

高等影像處理

作業#5

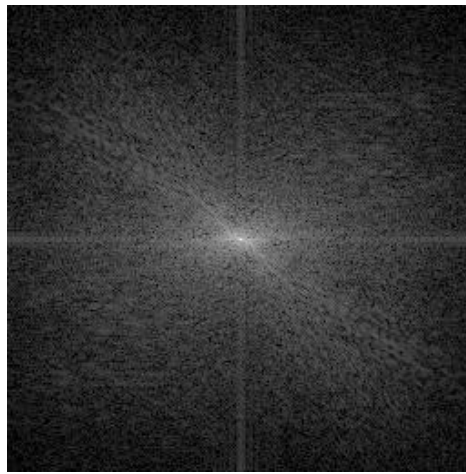
姓名：_____蘇柏凱_____

學號：_____111c71007_____

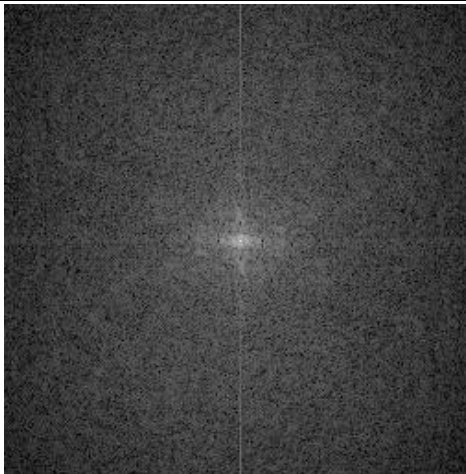
指導老師：_____李曉祺、蔣欣翰_____

1.1

Figure



dft_lena.png



dft_baboon.png

Discussion

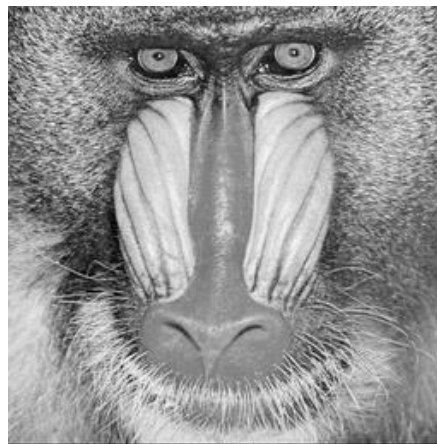
可以在 **lena** 的頻譜圖上看到比 **baboon** 多了兩個明顯斜的，整體而言更為集中，我這次 **DFT** 採用兩個 **1D** 的 **DFT** 變成 **2D DFT**，比起直接用 **2DDFT** 會快上不少，並且利用公式進行平移，並在最後除以 **pixel** 數量並把虛部、實部取平方合開根號，最後四捨五入*255，在 **contrast enhancement** 則是採用 **log** 的方式。

1.2

Figure



idft_lena.png



idft_baboon.png

```
1.2 baboon: _MSE :0  
1.2 baboon: _PSNR :inf  
1.2 lena: _MSE :0  
1.2 lena: _PSNR :inf
```

Discussion

IDFT 的結果可以發現兩張圖與原圖完全一樣， $MSE=0$ ， $PSNR$ 都無限大，因此可以驗證得知 DFT、IDFT 的正確性，一開始錯拿 SPECTRUM 的圖去做 IDFT 讓結果一直顯示錯誤，後來才發現問題並改用虛數、實數對進行 IDFT，IDFT 則是採用兩個 1D，因傳入的虛數、實數對尚未/pixel 數量，因此需要在最後除以 pixel 數量並把虛部、實部取平方合開根號。

1.3

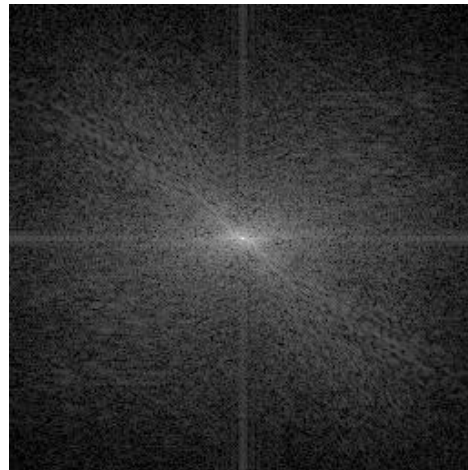
Figure

```
DFT Caluclate time :49.597  
DFT Caluclate time :49.424
```

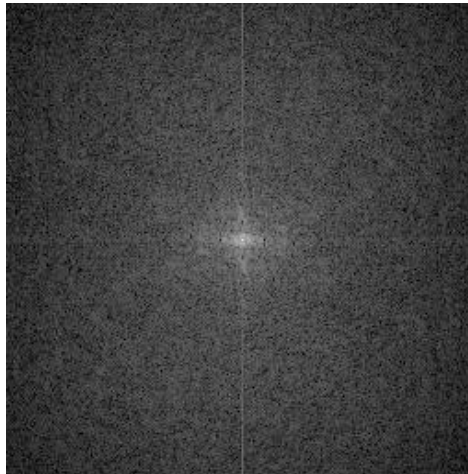
手刻結果

```
DFT Caluclate time :0.029  
DFT Caluclate time :0.007
```

Opencv 結果



cv_dft_lena.png



cv_dft_baboon.png

Discussion

上方為自己手刻版本的 2 個 1D DFT，opencv 的 DFT 可以明顯看出 0.029 秒比 49 秒快上許多，看了一下 opencv 的 document 可以發現 opencv 的 DFT 實際上是運行 FFT，加上利用了 multi-thread 進行優化，可以讓電腦更好的發揮出自己的效能， magnitude spectrum results 也一樣，差別就在於運算時間。

1.4

Figure

```
IDFT Caluclate time :26.36  
IDFT Caluclate time :26.354
```

手刻結果

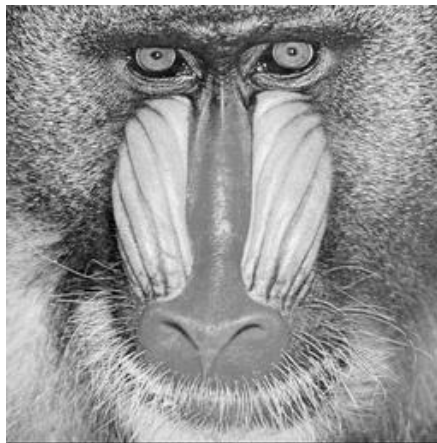
```
IDFT Caluclate time :0.028  
IDFT Caluclate time :0.025
```

Opencv 結果

```
1.4 lena : _MSE :0  
1.4 lena : _PSNR :inf  
1.4 baboon : _MSE :0  
1.4 baboon : _PSNR :inf
```




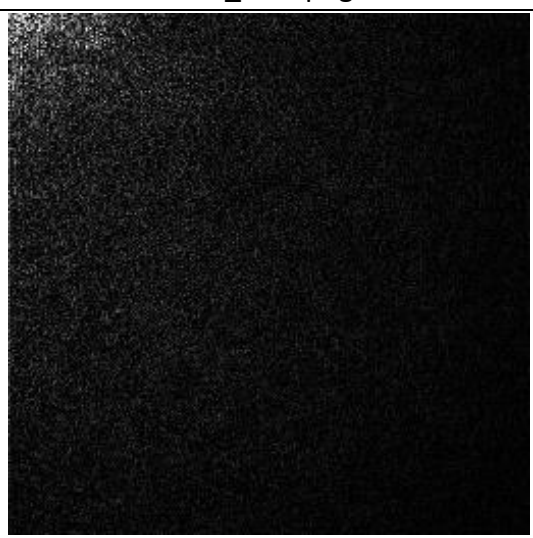
cv_idft_lena.png



cv_idft_baboon.png

Discussion

可以發現執行時間上 opencv 的 0.02 秒比己自己手刻版本的 26 秒快上許多，可能原因與上一題類似，演算法的優化、效能優化都是關鍵，而而 MSE 與 PSNR 與自己的手刻版本一樣，差別就在於運算時間。

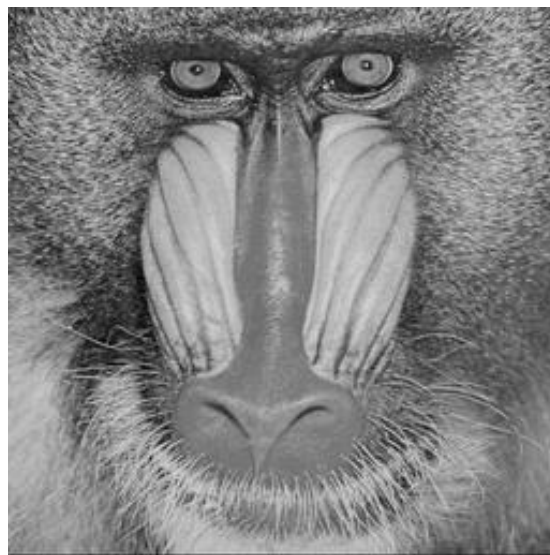
1.5		
Figure		
		
	dct_lena.png	
		
	dct_baboon.png	
<div><div>Description</div><div>The 2-D DCT block calculates the two-dimensional discrete cosine transform of an image. Suppose $f(x,y)$ is the input image of dimension $M \times N$.</div><div>$F(m,n) = \frac{2}{\sqrt{MN}} C(m)C(n) \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) \cos \frac{(2x+1)m\pi}{2M} \cos \frac{(2y+1)n\pi}{2N}$</div><div>where $C(m) = C(n) = 1/\sqrt{2}$ for $m, n = 0$ and $C(m), C(n) = 1$ otherwise.</div></div>		
<div><div>Discussion</div><div>延續之期的思路，DCT 也是採用兩個 1D 組成，但這次少了虛部、實部的問題，可以用一個實數來解決，只需要在最後把計算結果取絕對值並四捨五入。</div></div>		

1.6

Figure



idct_lena.png



idct_baboon.png

```
DCT Caluclate time :187.969
IDCT Caluclate time :190.453
DCT Caluclate time :188.748
IDCT Caluclate time :189.145
1.6 lena : _MSE :0
1.6 lena : _PSNR :inf
1.6 baboon : _MSE :0
1.6 baboon : _PSNR :inf
```

The 2-D IDCT block calculates the two-dimensional inverse discrete cosine transform of the input signal. The equation for the two-dimensional IDCT of

$$f(x,y)=\frac{2}{\sqrt{MN}}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}C(m)C(n)F(m,n)\cos\frac{(2x+1)m\pi}{2M}\cos\frac{(2y+1)n\pi}{2N},$$

where $F(m,n)$ is the discrete cosine transform (DCT) of the signal $f(x,y)$. If $m=n=0$, then $C(m)=C(n)=1/\sqrt{2}$. Otherwise $C(m)=C(n)=1$.

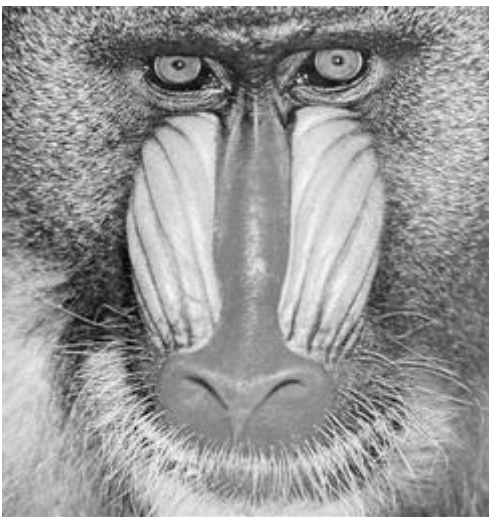

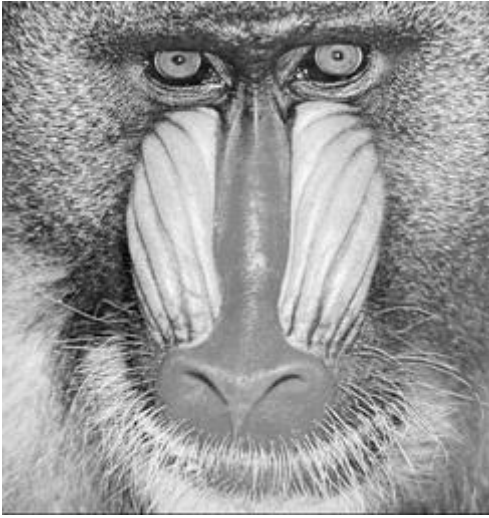

Discussion

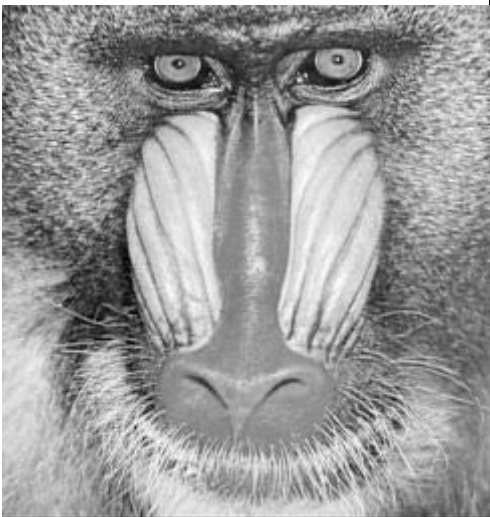
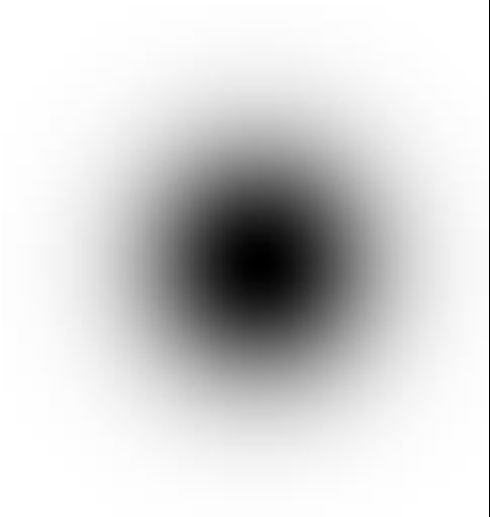
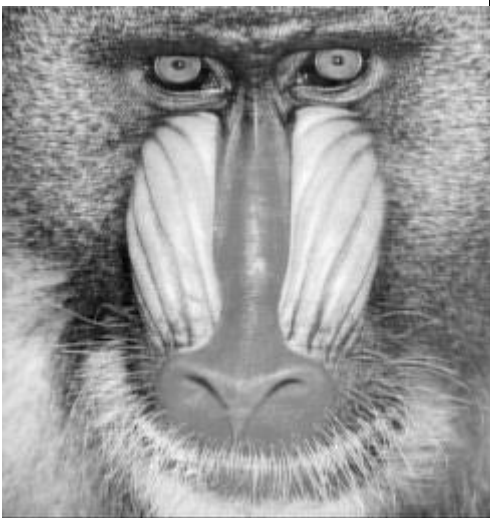
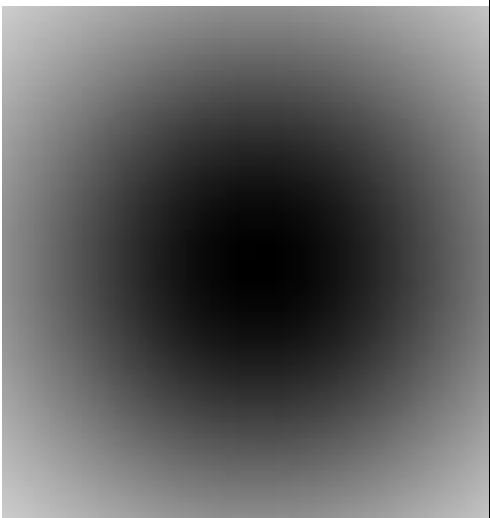

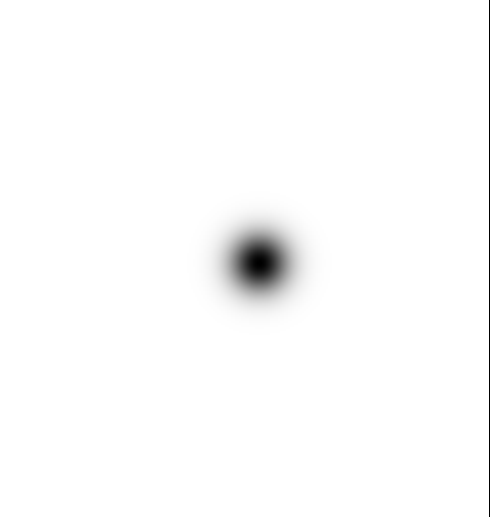
可以發現 IDCT 的結果也可以完全還原成原圖，MSE=0,PSNR=inf，因此也算得上是一個優良的演算法，依據上圖公式，只需在最後再取絕對值即可。




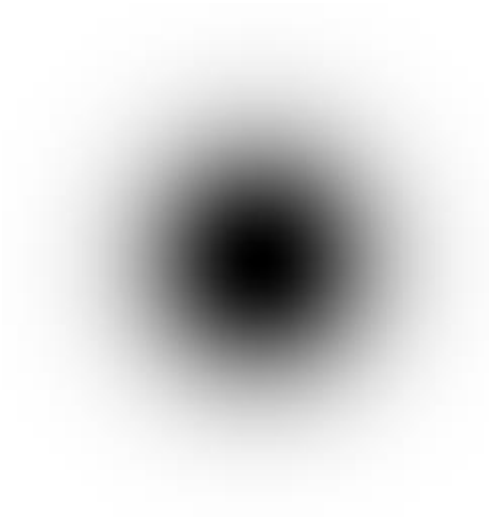
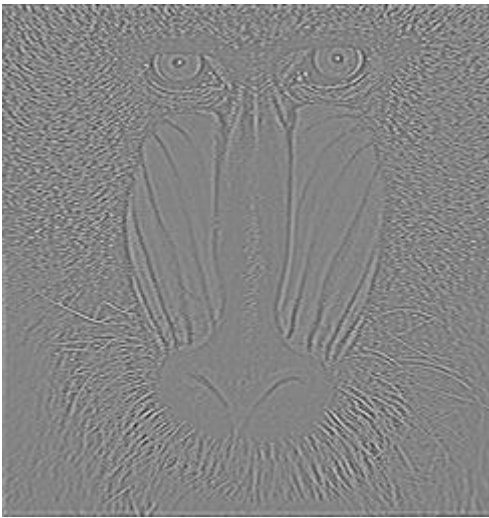
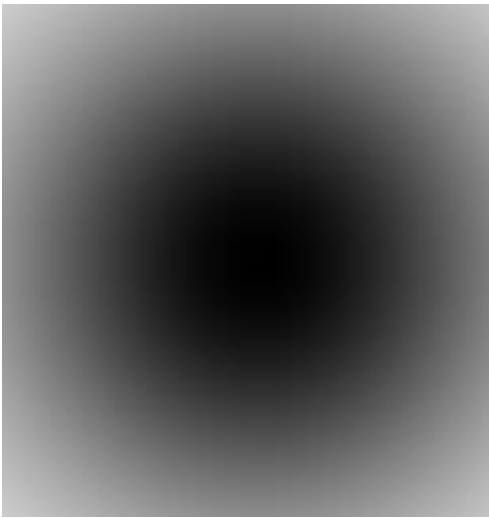
1.7

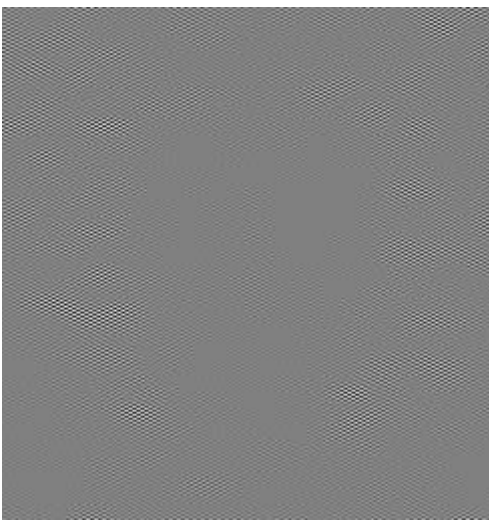
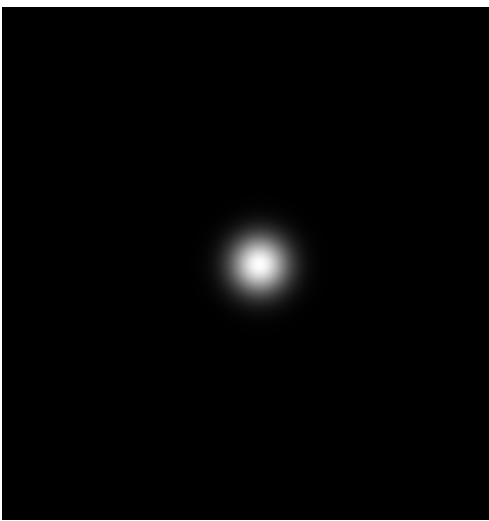
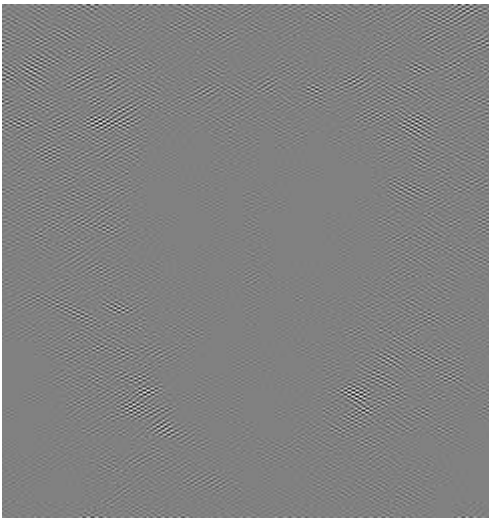
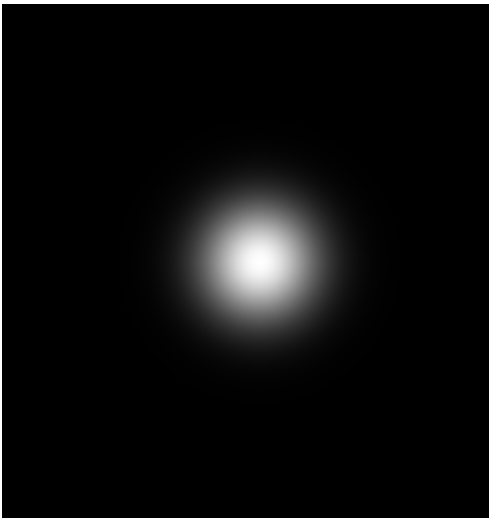
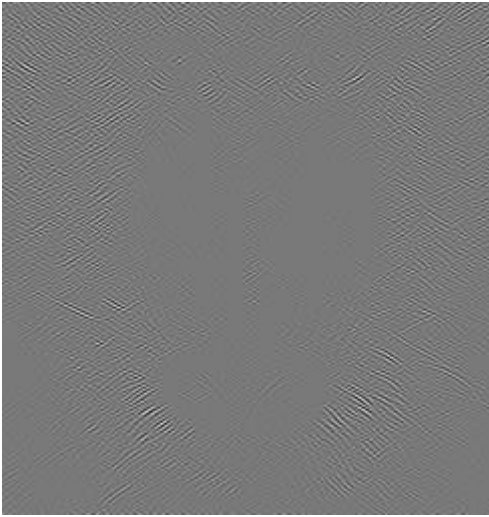

Discussion

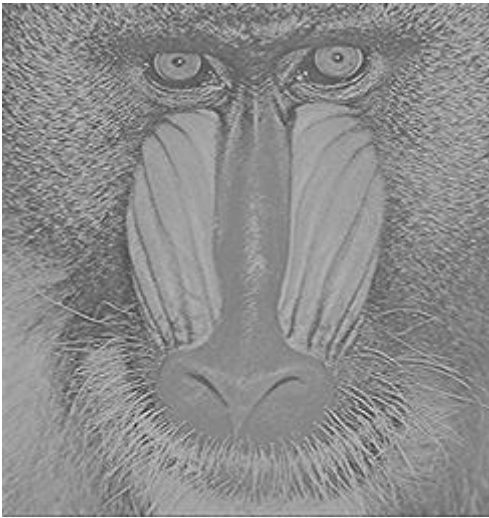
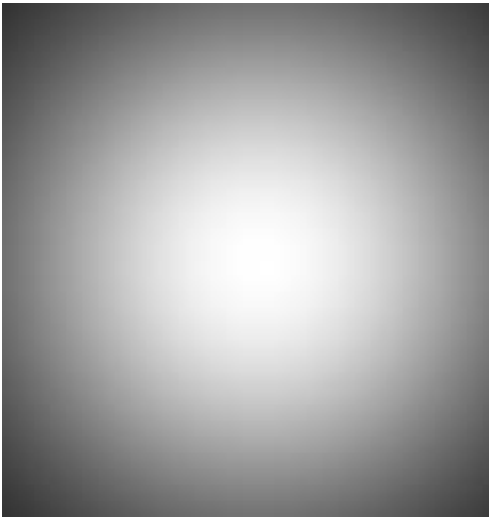

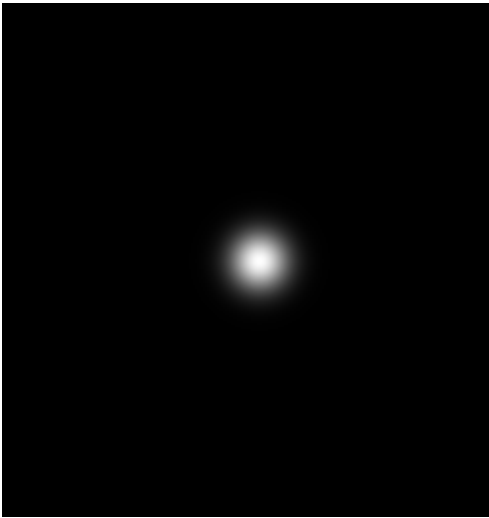
可以發現在 DFT 會有實數、虛數，而 DCT 僅有實數，雖然兩者的計算時間在手刻版本中由 DFT 勝出，但是計算量尚有許多優化空間 EX:DP 技巧、multi-threads 等等，而在圖像壓縮中，bit rate 是表示數據量的一個重要指標。由於 DCT 在能量集中和視覺特性上的優勢，它通常能夠以較低的 bit rate 實現相當於或更好於 DFT 的壓縮效果。這種 bit rate 的節省意味著在相同的壓縮比下，使用 DCT 進行圖像壓縮可以得到更小的數據文件，更適合在有限的儲存或傳輸帶寬條件下應用


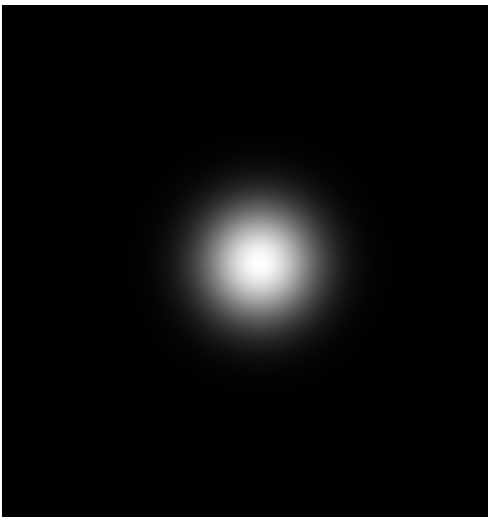


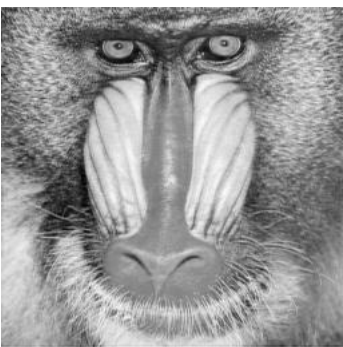
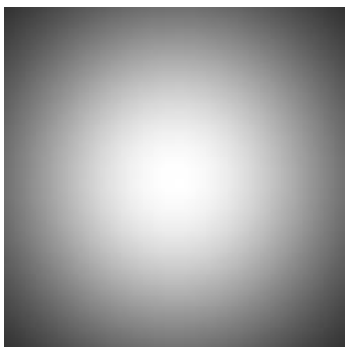
2.1		
Figure		
High pass filter without origin shifting		
D	image	spectrum
10	 HPF_D0_10.000000_IMG.png	 HPF_D0_10.000000_SPRCTRUM.png
20	 HPF_D0_20.000000_IMG.png	 HPF_D0_20.000000_SPRCTRUM.png

40	 <p>HPF_D0_40.000000_IMG.png</p>	 <p>HPF_D0_40.000000_SPRCTRUM.png</p>
10 0	 <p>HPF_D0_100.000000_IMG.png</p>	 <p>HPF_D0_100.000000_SPRCTRUM.png</p>
High pass filter with origin shifting		
D	image	spectrum
10		

	ORIGIN_HPF_D0_IMG10.000000_IMG.png	ORIGIN_HPF_D0_10.000000_SPRCTRUM.png
20		
40		
100		

Low pass filter without origin shifting		
D	image	spectrum
10	 LPF_D0_10.000000_IMG.png	 LPF_D0_10.000000_SPRCTRUM.png
20	 LPF_D0_20.000000_IMG.png	 LPF_D0_20.000000_SPRCTRUM.png
40		

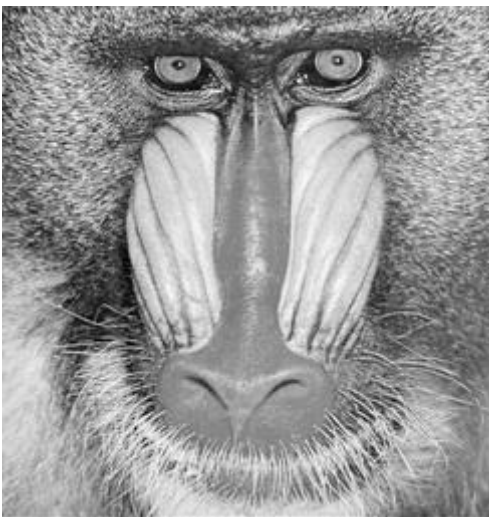

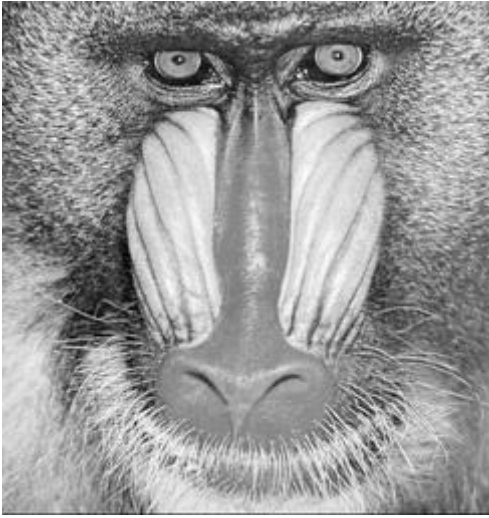

	LPF_D0_40.000000_IMG.png	LPF_D0_40.000000_SPRCTRUM.png
10 0		
	LPF_D0_100.000000_IMG.png	LPF_D0_100.000000_SPRCTRUM.png
Low pass filter with origin shifting		
D	image	spectrum
10		
	ORIGIN_LPF_D0_10.000000_IMG.png	ORIGIN_LPF_D0_10.000000_SPRCTRUM.png

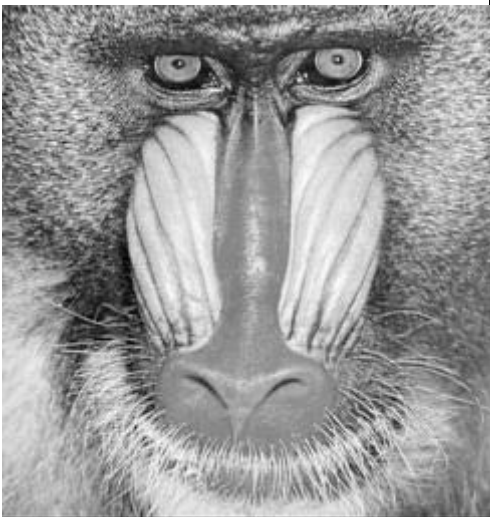
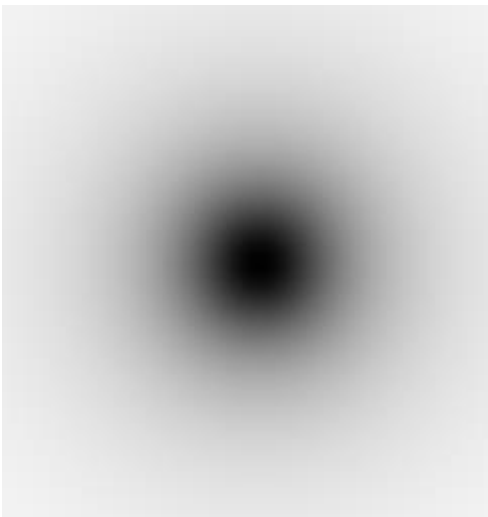
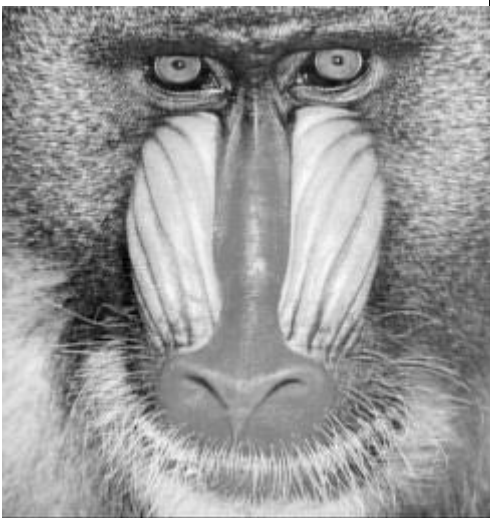
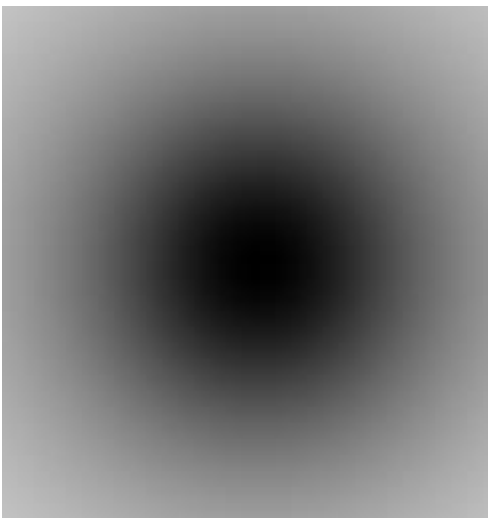
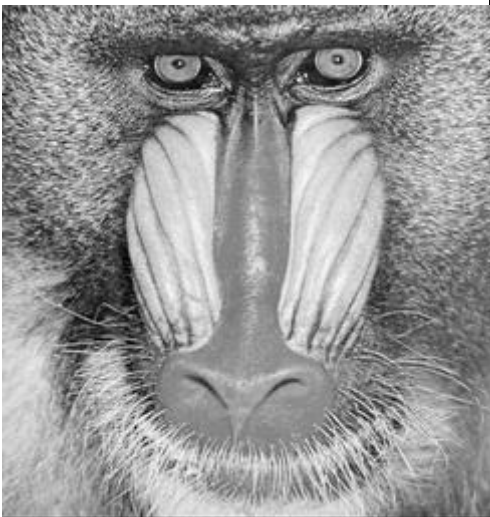

20	 ORIGIN_LPF_D0_20.000000_IMG.png	 ORIGIN_LPF_D0_20.000000_SPRCTRM.png
40	 ORIGIN_LPF_D0_40.000000_IMG.png	 ORIGIN_LPF_D0_40.000000_SPRCTRM.png
100	 ORIGIN_LPF_D0_100.000000_IMG.png	 ORIGIN_LPF_D0_100.000000_SPRCTRM.png

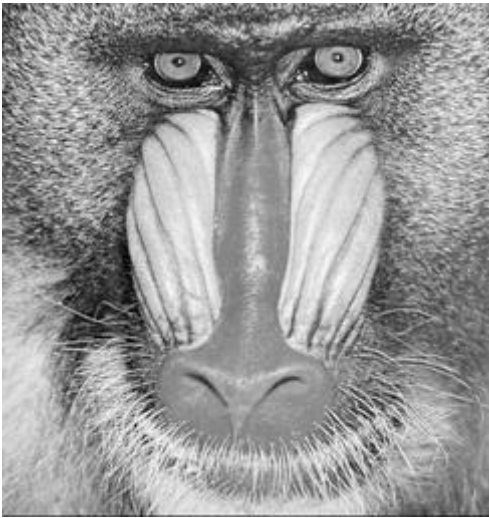

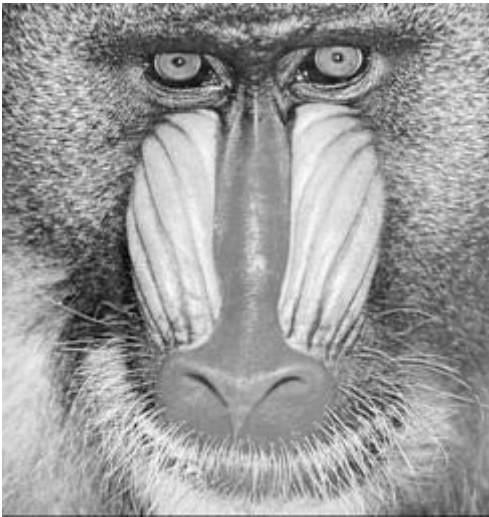
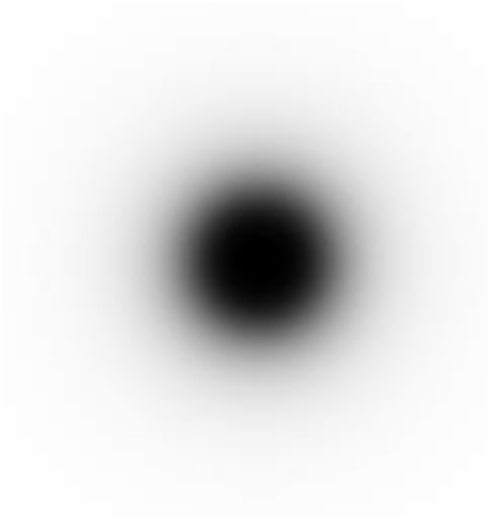
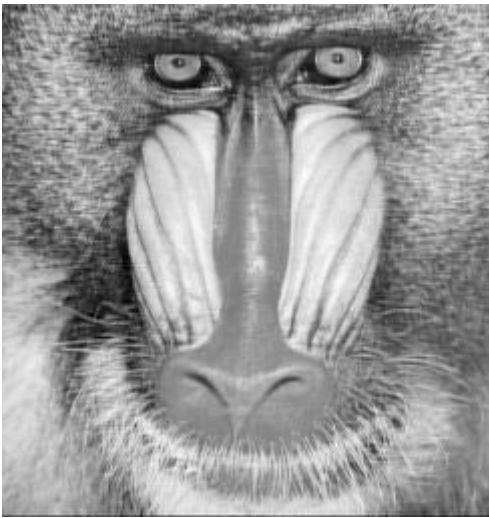
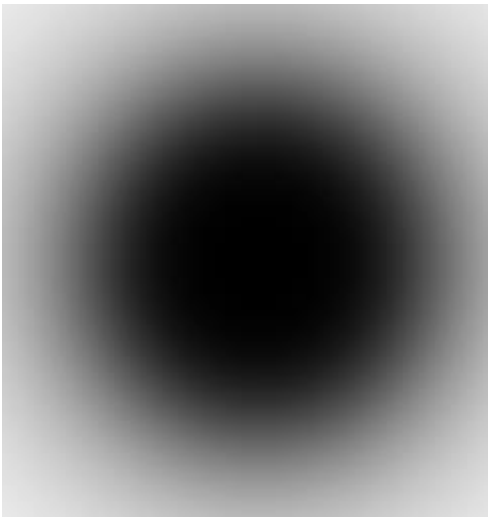
Discussion


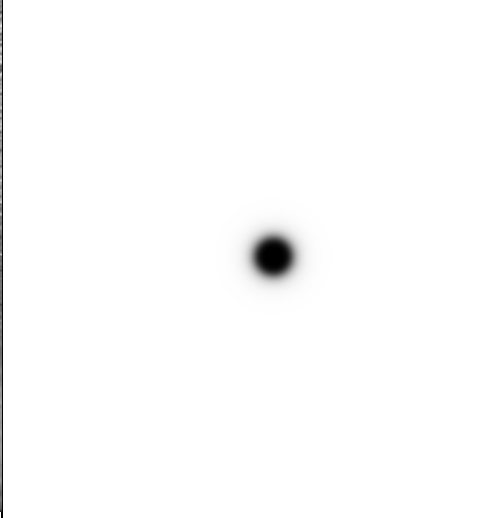
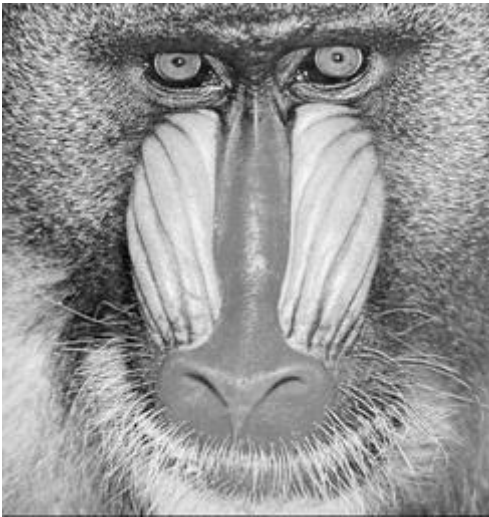
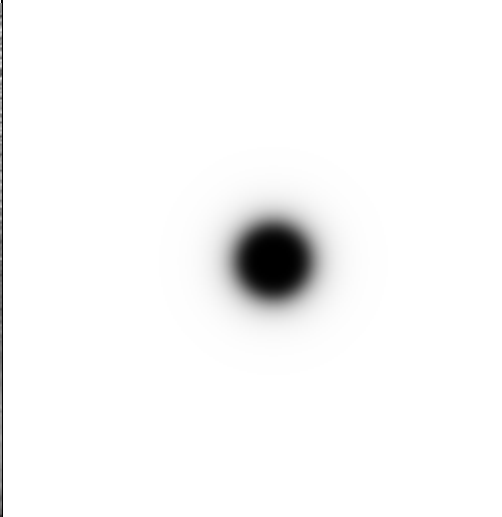
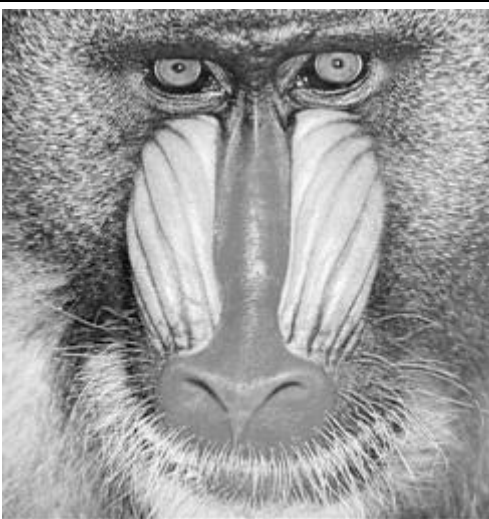
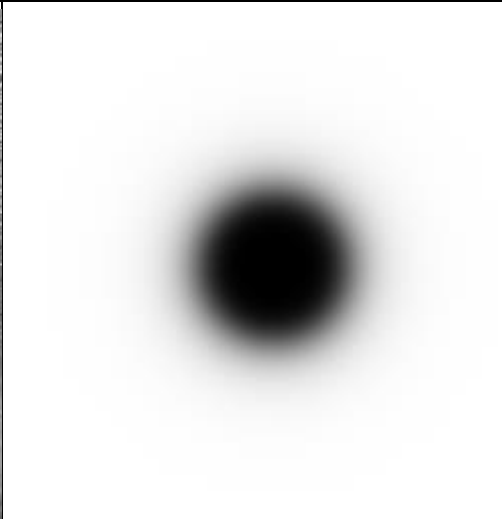
可以看到沒有做 **Origin shifting** 的版本不論是 **HPF** 或是 **LPF** 都顯得很怪異因為作用在高頻上所以跟我們的預期結果會相反，**HPT** 幾乎不受到模糊影響，**LPF** 則幾乎完全看不到資訊，而經過 **origin shifting** 的可以發現 **D** 越大 **LPF** 細節越多，**HPF** 則越來越模糊，因此題圖片數量較多另有開資料夾在 **image_file** 中的

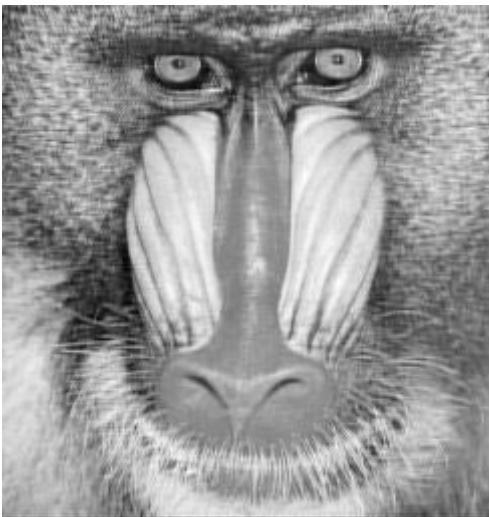
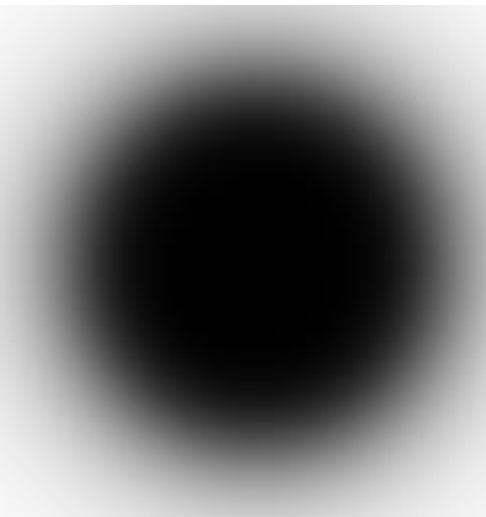
gaussian 内。。

2.2		
Figure		
High pass filter without origin shifting n=1		
D	image	spectrum
10	 Butterworth_HPF_D0_10_n_1.png	 HPF_D0_10_n_1_SPRCTRUM.png
20	 Butterworth_HPF_D0_20_n_1.png	 HPF_D0_20_n_1_SPRCTRUM.png

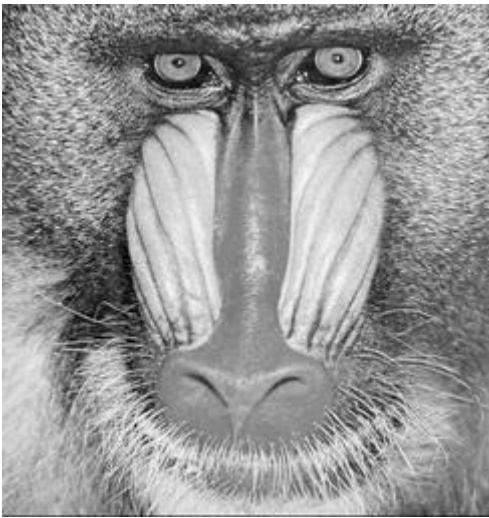

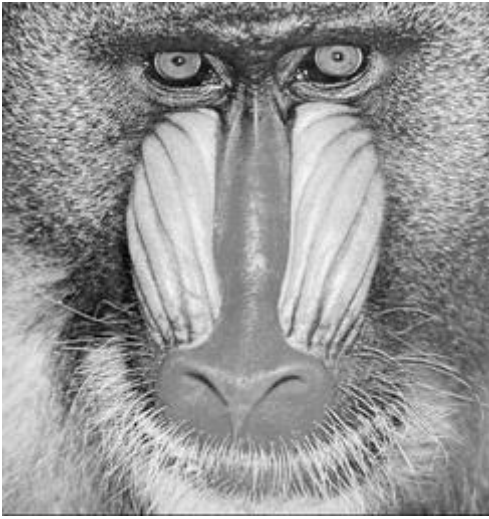

40	 <p>Butterworth_HPF_D0_40_n_1.png</p>	 <p>HPF_D0_40_n_1_SPRCTRUM.png</p>
100	 <p>Butterworth_HPF_D0_100_n_1.png</p>	 <p>HPF_D0_100_n_1_SPRCTRUM.png</p>
High pass filter without origin shifting n=2		
D	image	spectrum
10		

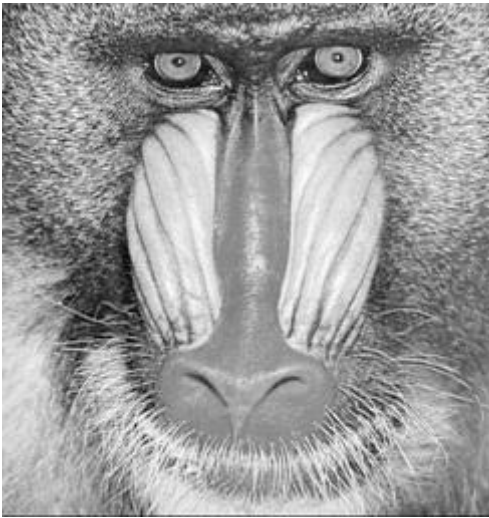

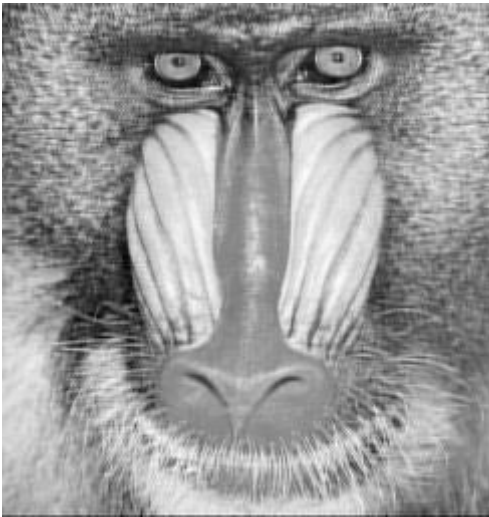
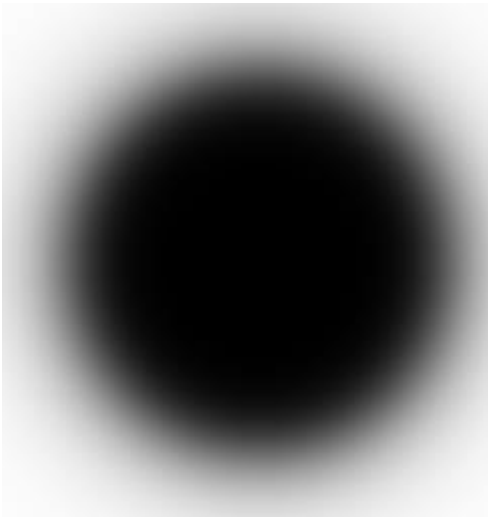
	Butterworth_HPF_D0_10_n_2.png	HPF_D0_10_n_2_SPRCTRUM.png
20		
	Butterworth_HPF_D0_20_n_2.png	HPF_D0_20_n_2_SPRCTRUM.png
40		
	Butterworth_HPF_D0_40_n_2.png	HPF_D0_40_n_2_SPRCTRUM.png
100		
	Butterworth_HPF_D0_100_n_2.png	HPF_D0_100_n_2_SPRCTRUM.png

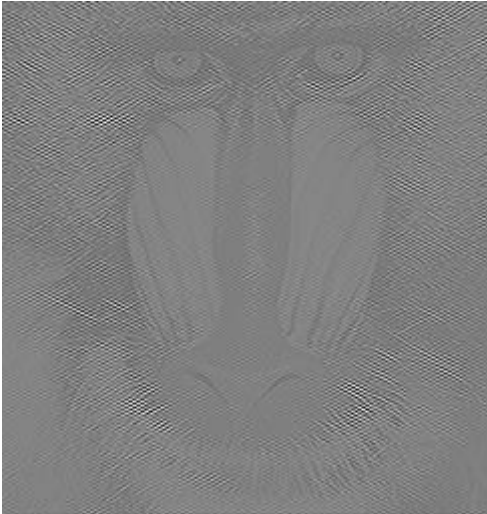
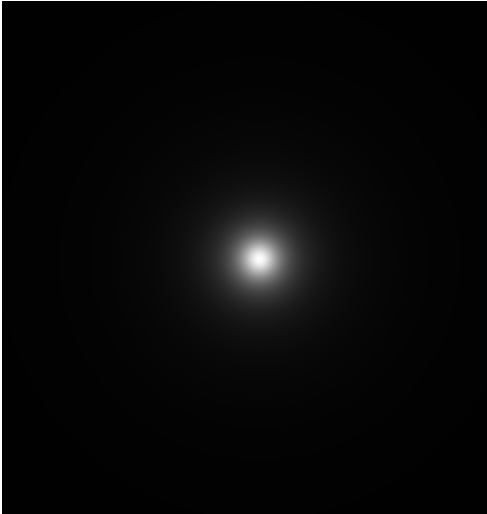
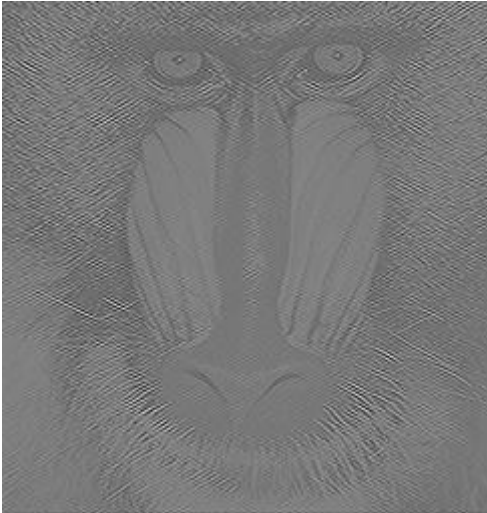
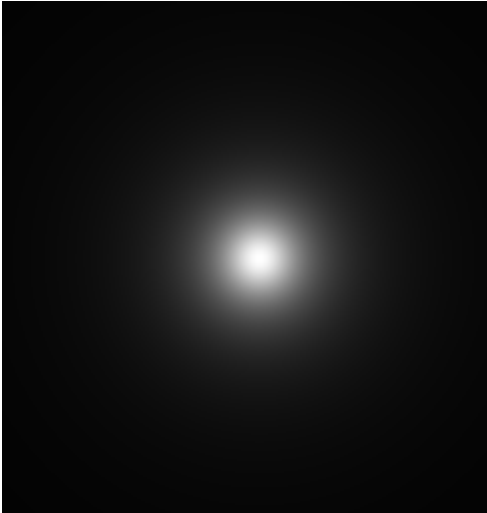
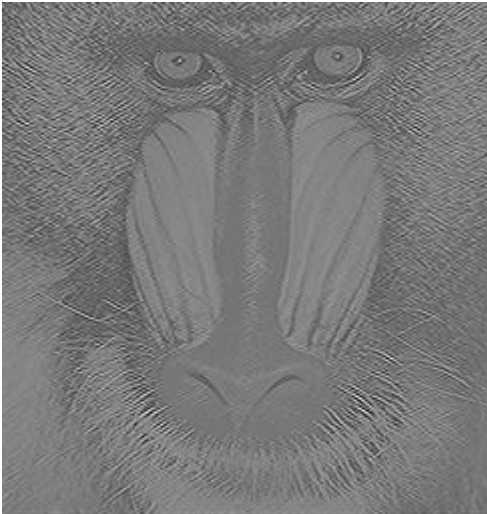

High pass filter without origin shifting $n=3$		
D	image	spectrum
10	 <p>Butterworth_HPF_D0_10_n_3.png</p>	 <p>HPF_D0_10_n_3_SPRCTRUM.png</p>
20	 <p>Butterworth_HPF_D0_20_n_3.png</p>	 <p>HPF_D0_20_n_3_SPRCTRUM.png</p>
40	 <p>Butterworth_HPF_D0_40_n_3.png</p>	 <p>HPF_D0_40_n_3_SPRCTRUM.png</p>

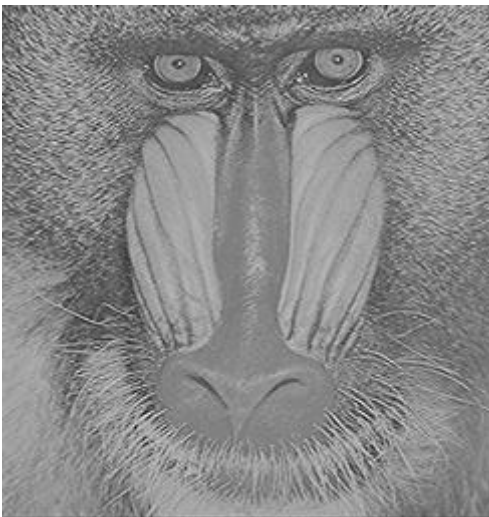
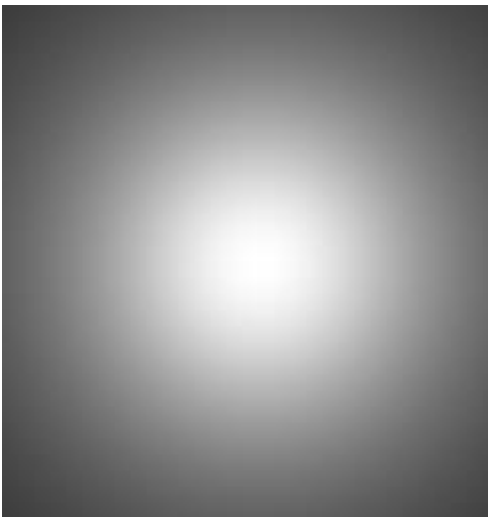
10 0		
	Butterworth_HPF_D0_100_n_3.png	HPF_D0_100_n_3_SPRCTRUM.png

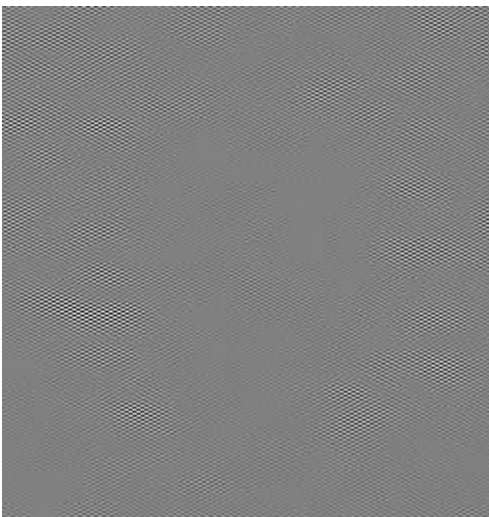
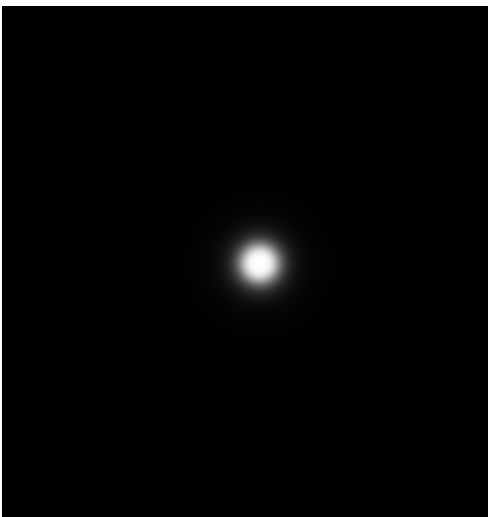
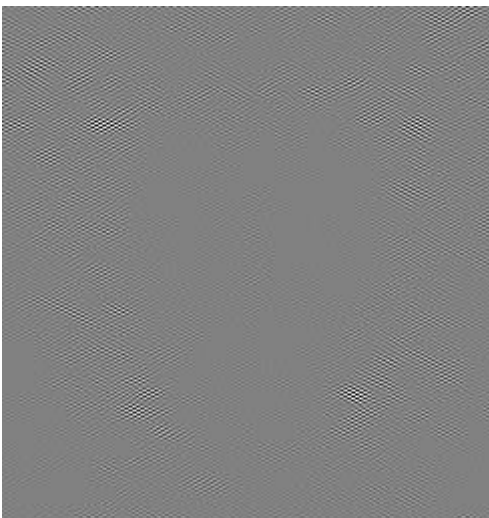
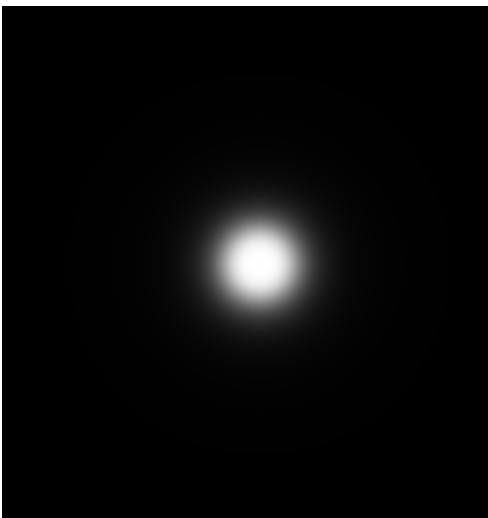
High pass filter without origin shifting n=4		
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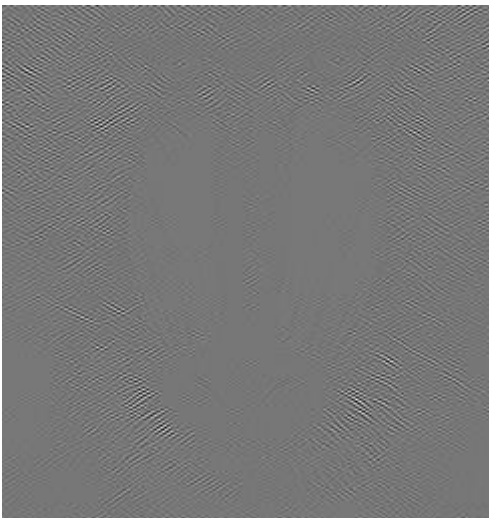

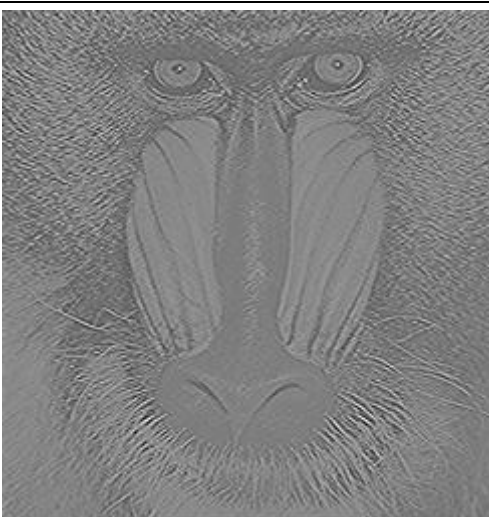
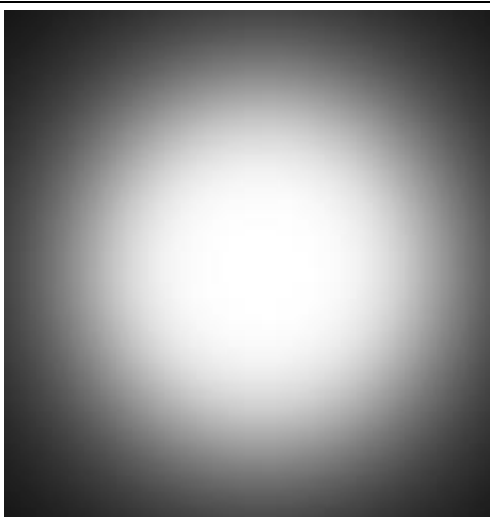
D	image	spectrum
10		
	Butterworth_HPF_D0_10_n_4.png	HPF_D0_10_n_4_SPRCTRUM.png
20		

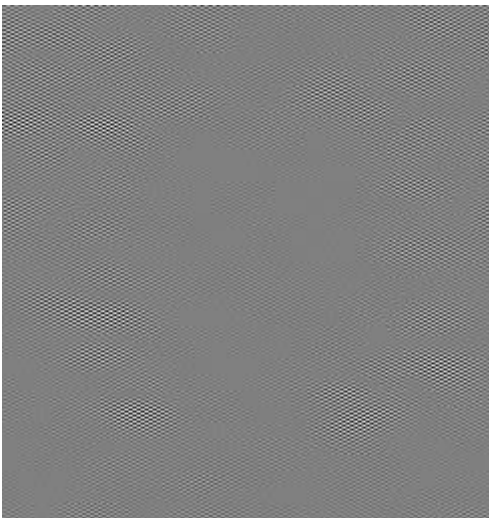
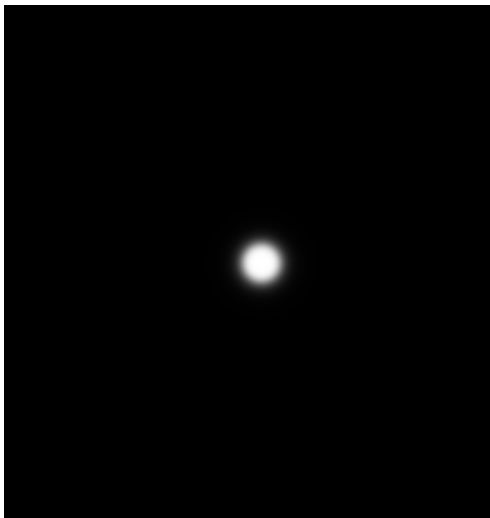
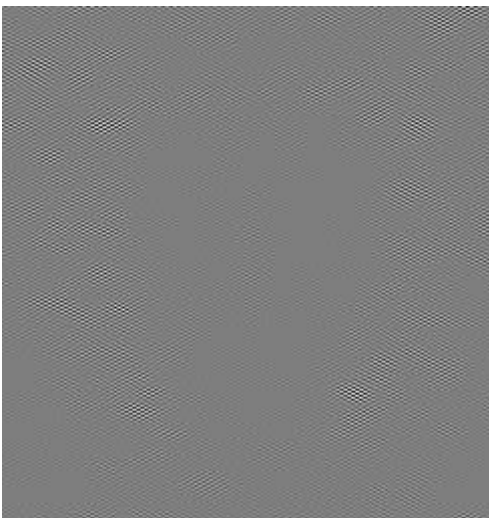
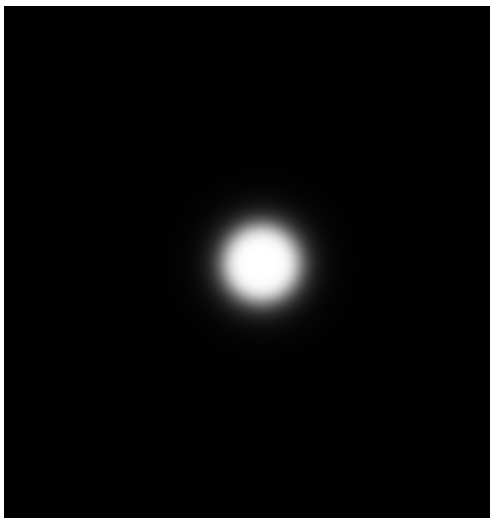
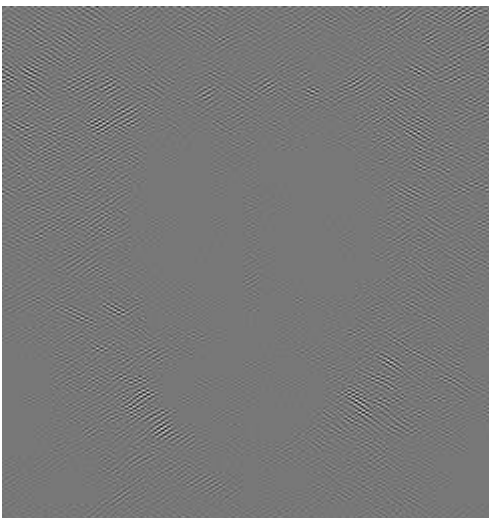

	Butterworth_HPF_D0_20_n_4.png	HPF_D0_20_n_4_SPRCTUM.png
40		
	Butterworth_HPF_D0_40_n_4.png	HPF_D0_40_n_4_SPRCTUM.png
100		
	Butterworth_HPF_D0_100_n_4.png	HPF_D0_100_n_4_SPRCTUM.png
Low pass filter without origin shifting n=1		
D	image	spectrum

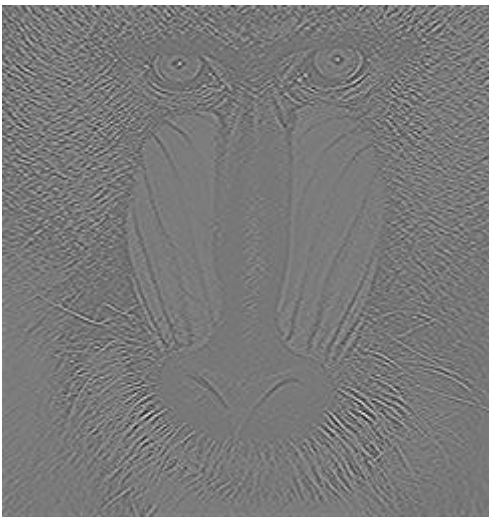

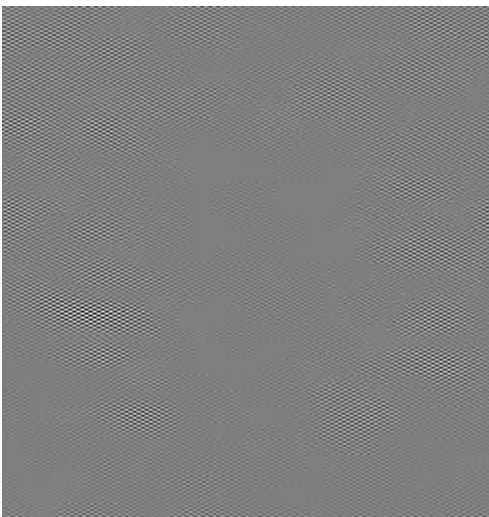
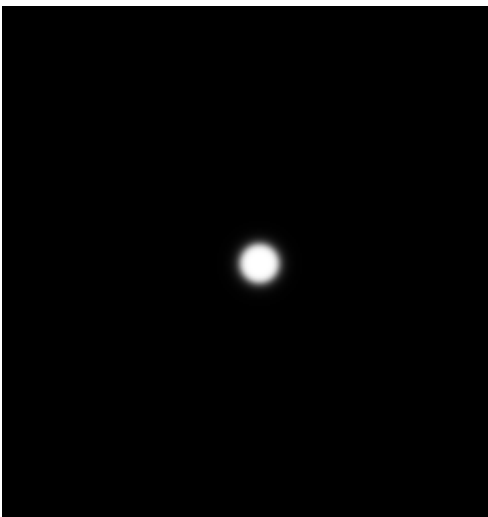
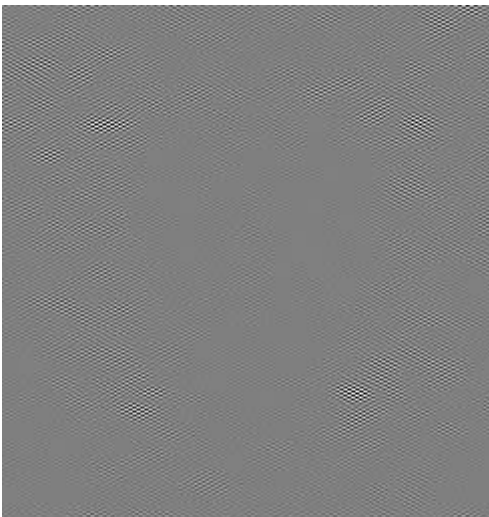

10	 <p>Butterworth_LPF_D0_10_n_1.png</p>	 <p>LPF_D0_10_n_1_SPRCTRUM.png</p>
20	 <p>Butterworth_HPF_D0_20_n_1.png</p>	 <p>LPF_D0_20_n_1_SPRCTRUM.png</p>
40	 <p>Butterworth_LPF_D0_40_n_1.png</p>	 <p>LPF_D0_40_n_1_SPRCTRUM.png</p>

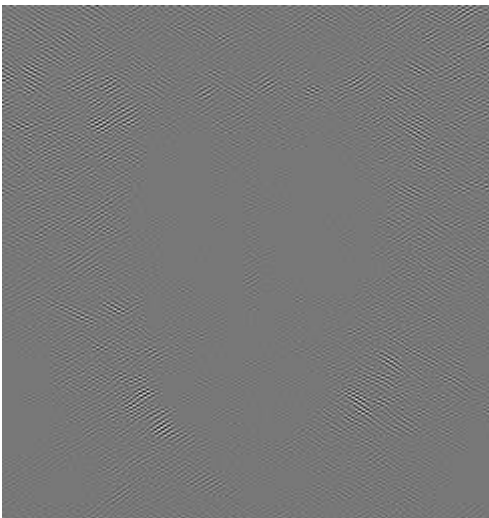


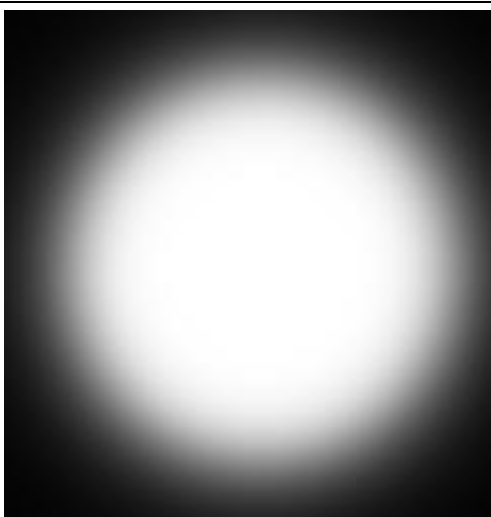
10 0		
	Butterworth_LPF_D0_100_n_1.png	LPF_D0_100_n_1_SPRCTRUM.png






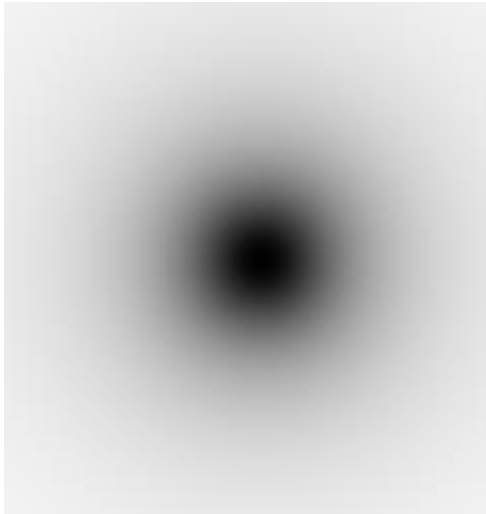
Low pass filter without origin shifting n=2		
D	image	spectrum
10		
	Butterworth_LPF_D0_10_n_2.png	LPF_D0_10_n_2_SPRCTRUM.png
20		


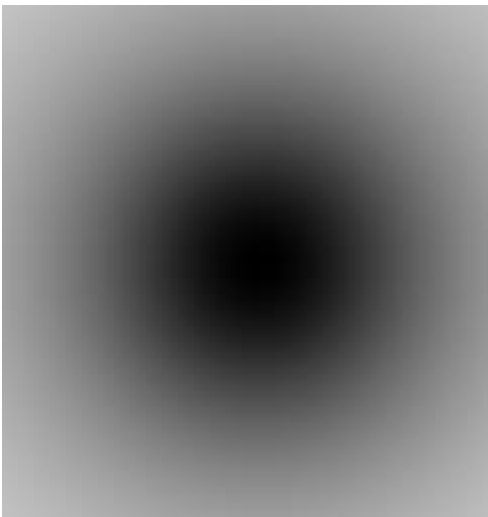




	Butterworth_LPF_D0_20_n_2.png	LPF_D0_20_n_2_SPRCTRUM.png
40		
	Butterworth_LPF_D0_40_n_2.png	LPF_D0_40_n_2_SPRCTRUM.png
100		
	Butterworth_LPF_D0_100_n_2.png	LPF_D0_100_n_2_SPRCTRUM.png
Low pass filter without origin shifting n=3		
D	image	spectrum


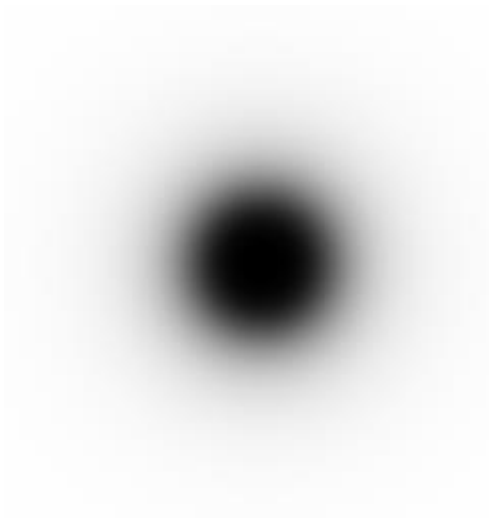
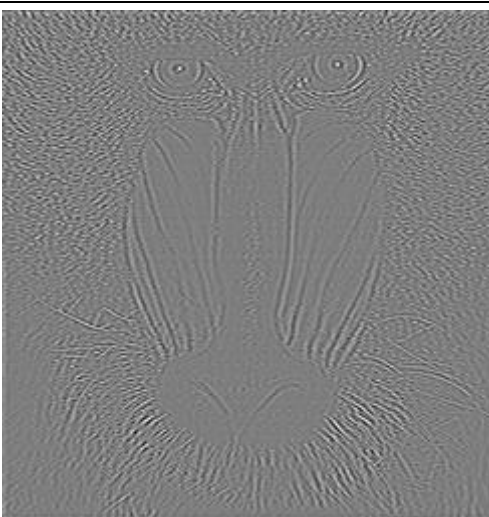
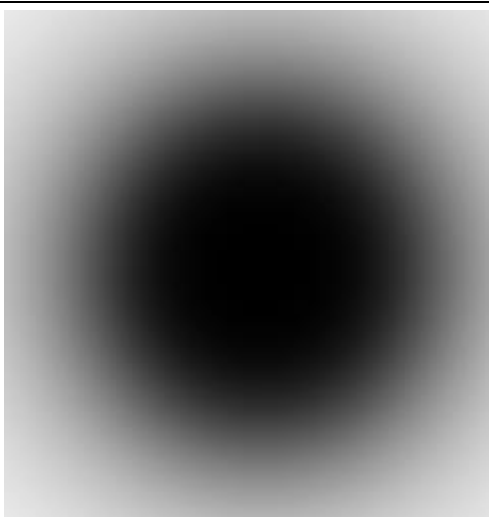
10	 <p>Butterworth_LPF_D0_10_n_3.png</p>	 <p>LPF_D0_10_n_3_SPRCTRUM.png</p>
20	 <p>Butterworth_LPF_D0_20_n_3.png</p>	 <p>LPF_D0_20_n_3_SPRCTRUM.png</p>
40	 <p>Butterworth_LPF_D0_40_n_3.png</p>	 <p>LPF_D0_40_n_3_SPRCTRUM.png</p>





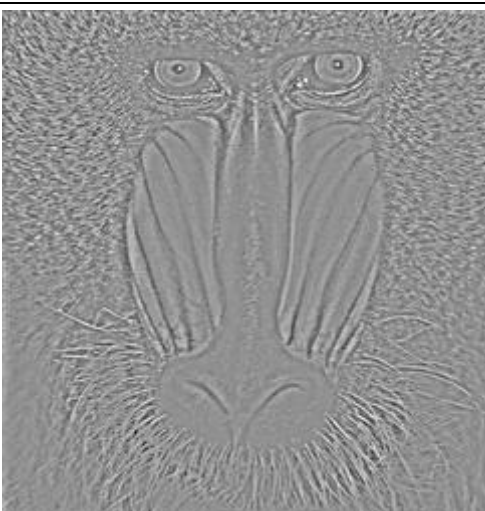

10 0		
Butterworth_LPF_D0_100_n_3.png		
LPF_D0_100_n_3_SPRCTRUM.png		
Low pass filter without origin shifting n=4		
D	image	spectrum
10		
Butterworth_LPF_D0_10_n_4.png		LPF_D0_10_n_4_SPRCTRUM.png
20		

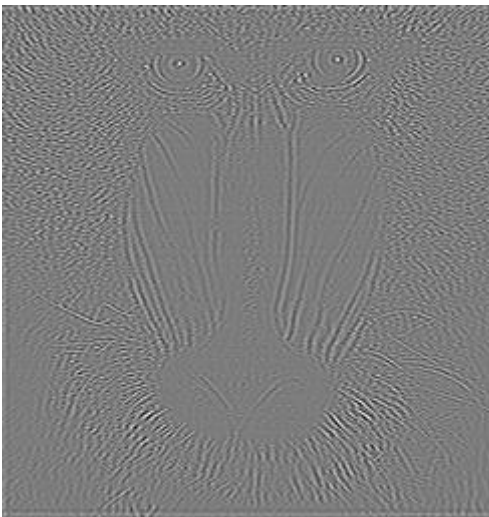
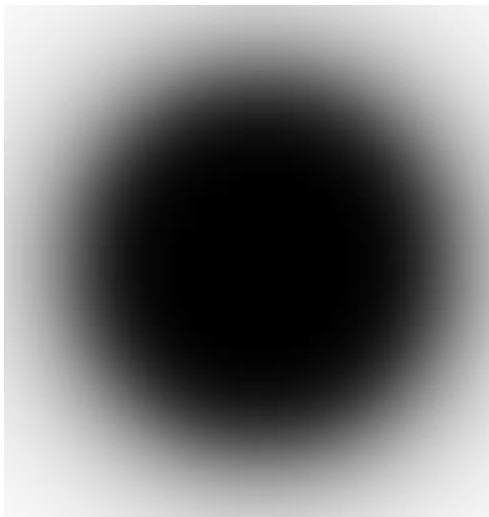




	Butterworth_LPF_D0_20_n_4.png	LPF_D0_20_n_4_SPRCTRUM.png
40		
	Butterworth_LPF_D0_40_n_4.png	LPF_D0_40_n_4_SPRCTRUM.png
100		
	Butterworth_LPF_D0_100_n_4.png	LPF_D0_100_n_4_SPRCTRUM.png
High pass filter with origin shifting n=1		
D	image	spectrum

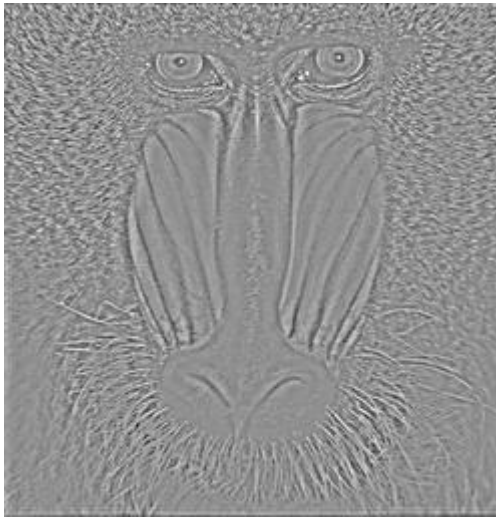

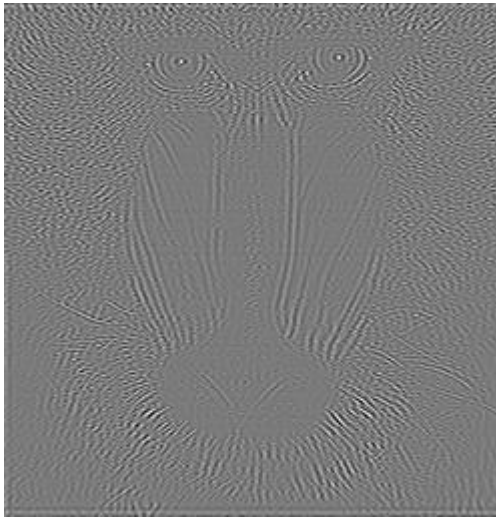
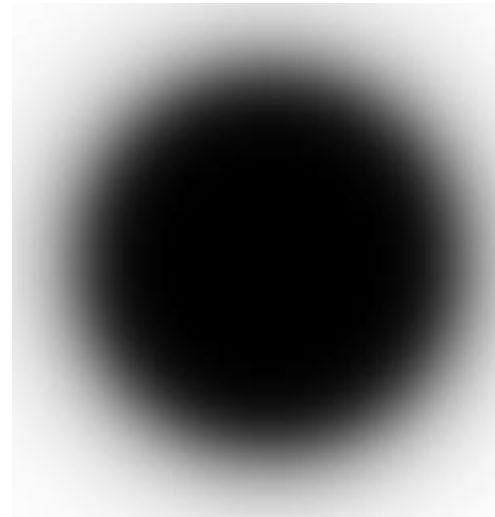
10	 <p data-bbox="343 728 821 761">ORIGIN_Butterworth_HPF_D0_10_n_1.png</p>	 <p data-bbox="845 728 1324 761">ORIGIN_HPF_D0_10_n_1_SPRCTURM.png</p>
20	 <p data-bbox="343 1301 821 1335">ORIGIN_Butterworth_HPF_D0_20_n_1.png</p>	 <p data-bbox="845 1301 1324 1335">ORIGIN_HPF_D0_20_n_1_SPRCTURM.png</p>
40	 <p data-bbox="343 1877 821 1910">ORIGIN_Butterworth_HPF_D0_40_n_1.png</p>	 <p data-bbox="845 1877 1324 1910">ORIGIN_HPF_D0_40_n_1_SPRCTURM.png</p>


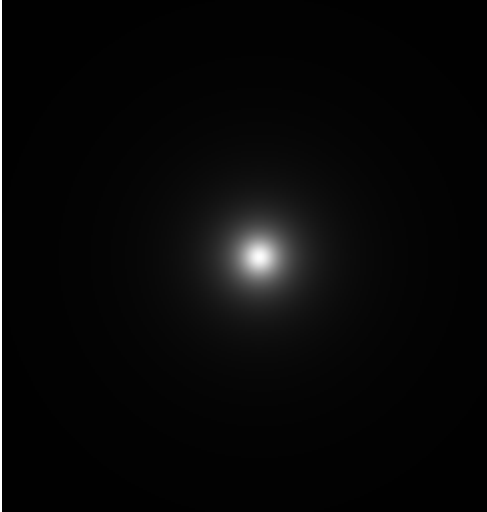

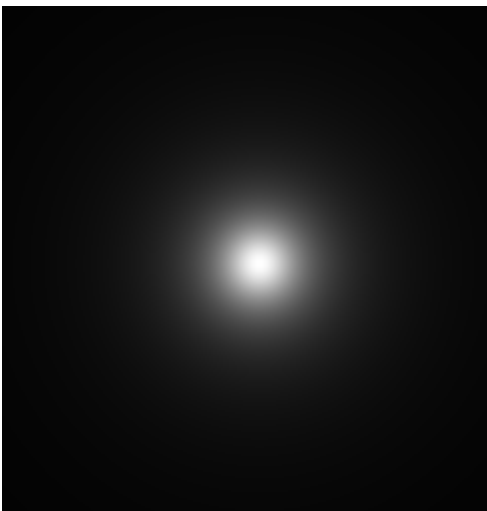


10 0		
	ORIGIN_Butterworth_HPF_D0_100_n_1.png	ORIGIN_HPF_D0_100_n_1_SPRCTUM.png
High pass filter with origin shifting n=2		
D	image	spectrum
10		
	ORIGIN_Butterworth_HPF_D0_10_n_2.png	ORIGIN_HPF_D0_10_n_2_SPRCTUM.png
20		

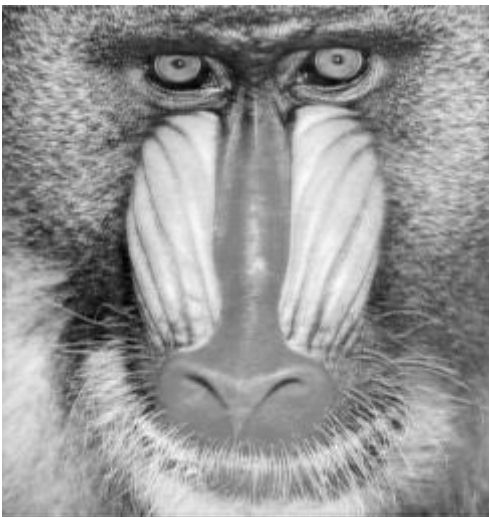
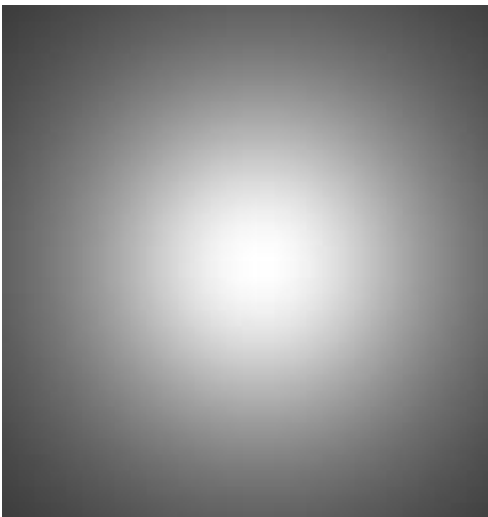

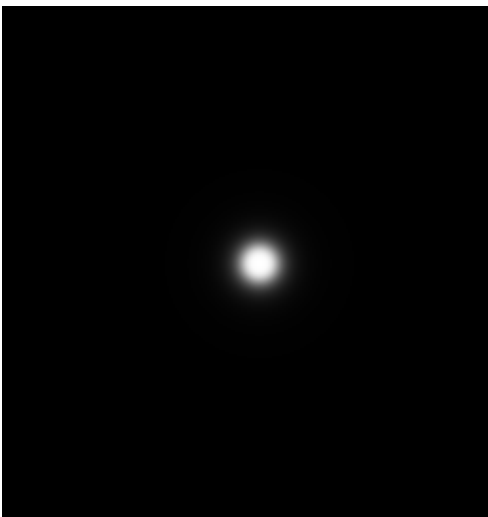

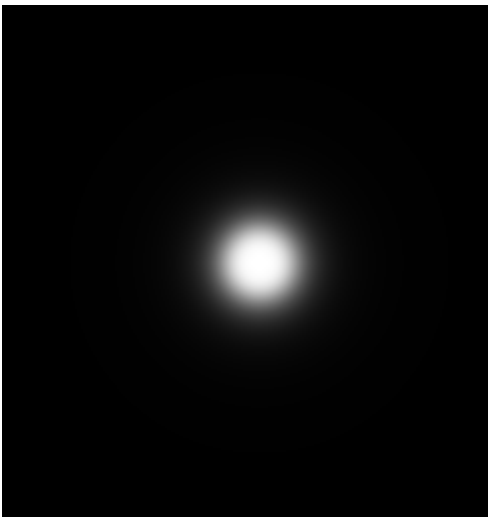
	ORIGIN_Butterworth_HPF_D0_20_n_2.png	ORIGIN_HPF_D0_20_n_2_SPRCTRUM.png
40		
	ORIGIN_Butterworth_HPF_D0_40_n_2.png	ORIGIN_HPF_D0_40_n_2_SPRCTRUM.png
100		
	ORIGIN_Butterworth_HPF_D0_100_n_2.png	ORIGIN_HPF_D0_100_n_2_SPRCTRUM.png
High pass filter with origin shifting n=3		
D	image	spectrum



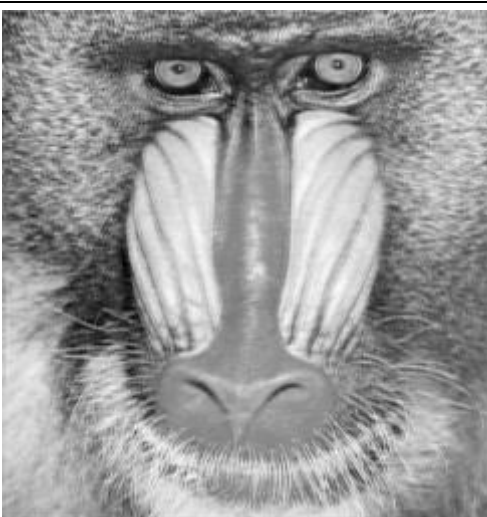
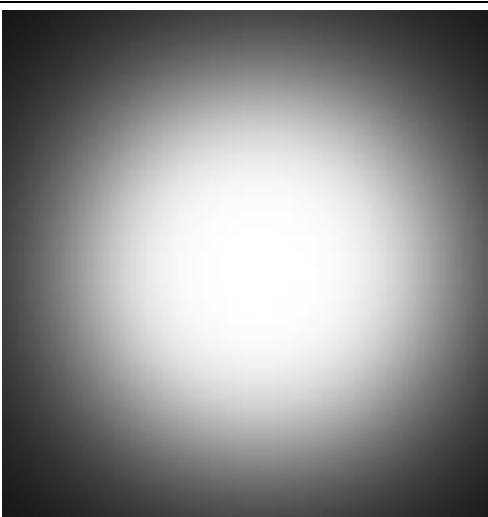
10	 <p data-bbox="343 728 821 761">ORIGIN_Butterworth_HPF_D0_10_n_3.png</p>	 <p data-bbox="845 728 1324 761">ORIGIN_HPF_D0_10_n_3_SPRCTUM.png</p>
20	 <p data-bbox="343 1299 821 1332">ORIGIN_Butterworth_HPF_D0_20_n_3.png</p>	 <p data-bbox="845 1299 1324 1332">ORIGIN_HPF_D0_20_n_3_SPRCTUM.png</p>
40	 <p data-bbox="343 1870 821 1904">ORIGIN_Butterworth_HPF_D0_40_n_3.png</p>	 <p data-bbox="845 1870 1324 1904">ORIGIN_HPF_D0_40_n_3_SPRCTUM.png</p>


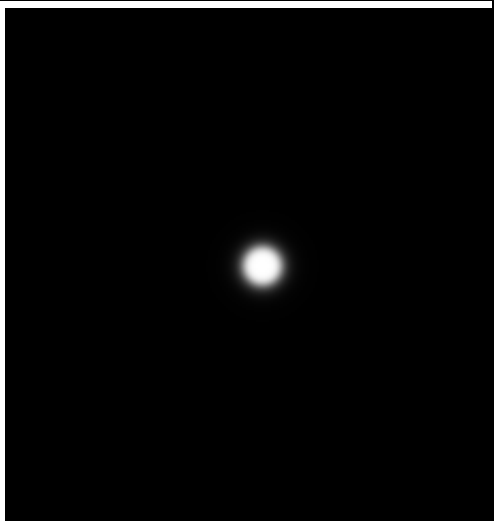

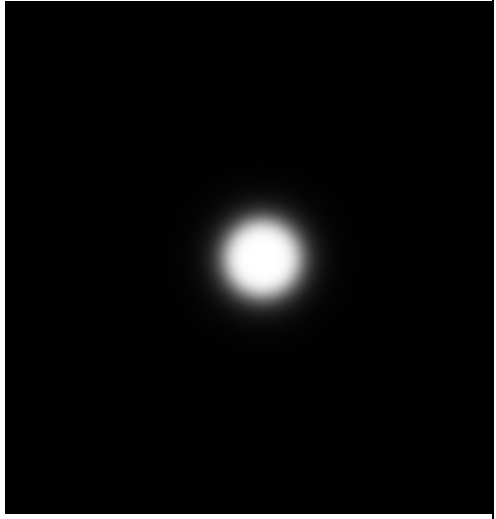

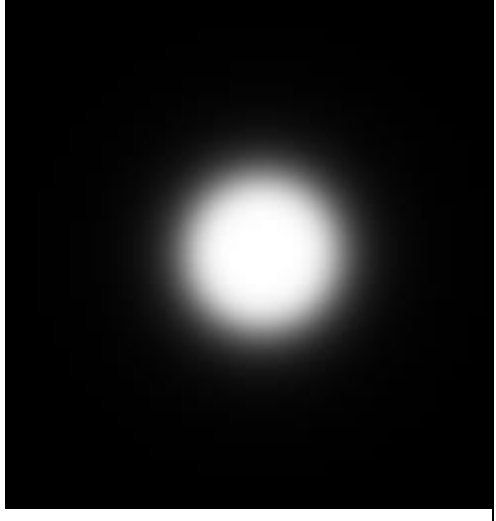
10 0		
	ORIGIN_Butterworth_HPF_D0_100_n_3.png	ORIGIN_HPF_D0_100_n_3_SPRCTRUM.png
High pass filter with origin shifting n=4		
D	image	spectrum
10		
	ORIGIN_Butterworth_HPF_D0_10_n_4.png	ORIGIN_HPF_D0_10_n_4_SPRCTRUM.png
20		

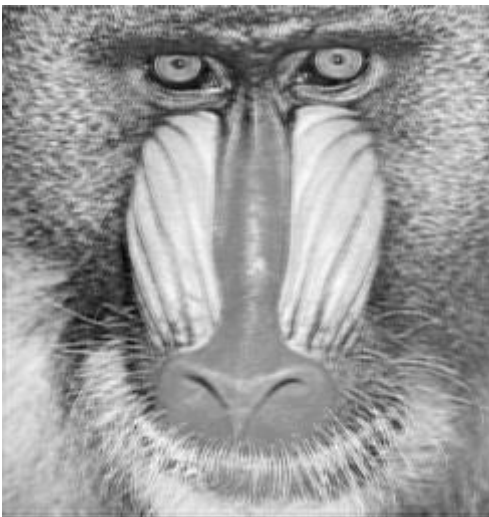
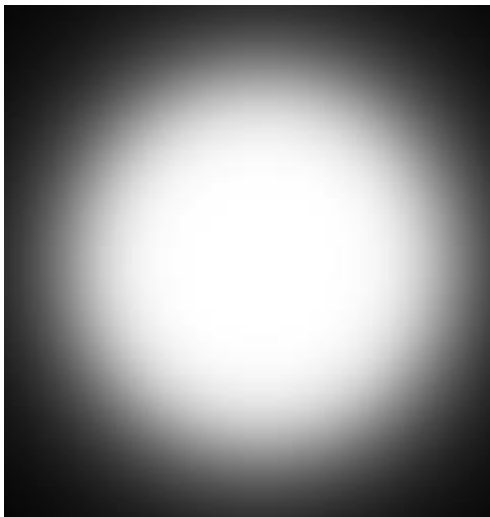

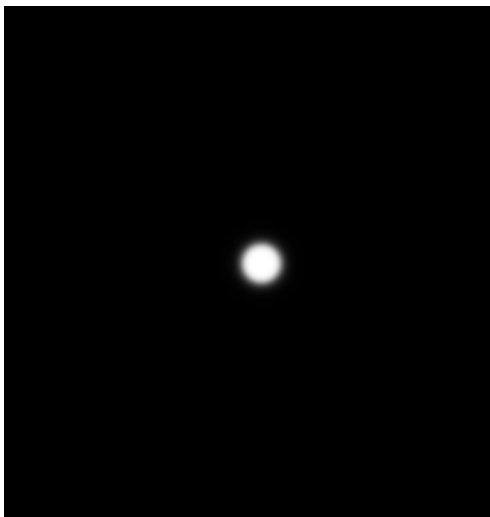


	ORIGIN_Butterworth_HPF_D0_20_n_4.png	ORIGIN_HPF_D0_20_n_4_SPRCTRUM.png
40		
	ORIGIN_Butterworth_HPF_D0_40_n_4.png	ORIGIN_HPF_D0_40_n_4_SPRCTRUM.png
100		
	ORIGIN_Butterworth_HPF_D0_100_n_4.png	ORIGIN_HPF_D0_100_n_4_SPRCTRUM.png
Low pass filter with origin shifting n=1		
D	image	spectrum



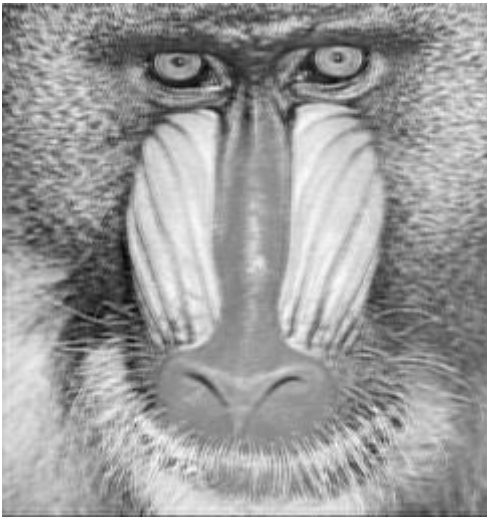

10	 <p data-bbox="371 730 791 759">ORIGIN_Butterworth_LPF_D0_10_n_1.png</p>	 <p data-bbox="879 730 1299 759">ORIGIN_LPF_D0_10_n_1_SPRCTRUM.png</p>
20	 <p data-bbox="371 1305 791 1335">ORIGIN_Butterworth_LPF_D0_20_n_1.png</p>	 <p data-bbox="879 1305 1299 1335">ORIGIN_LPF_D0_20_n_1_SPRCTRUM.png</p>
40	 <p data-bbox="371 1881 791 1910">ORIGIN_Butterworth_LPF_D0_40_n_1.png</p>	 <p data-bbox="879 1881 1299 1910">ORIGIN_LPF_D0_40_n_1_SPRCTRUM.png</p>


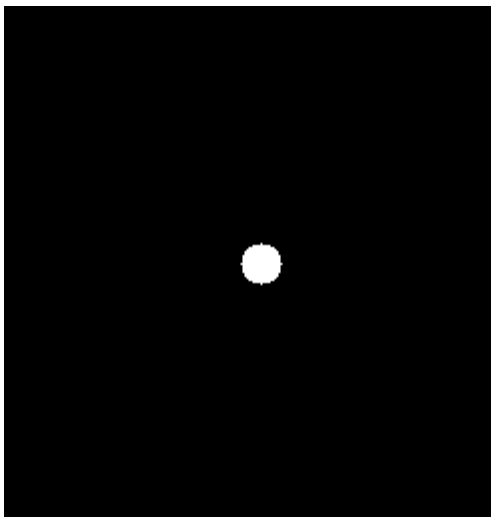

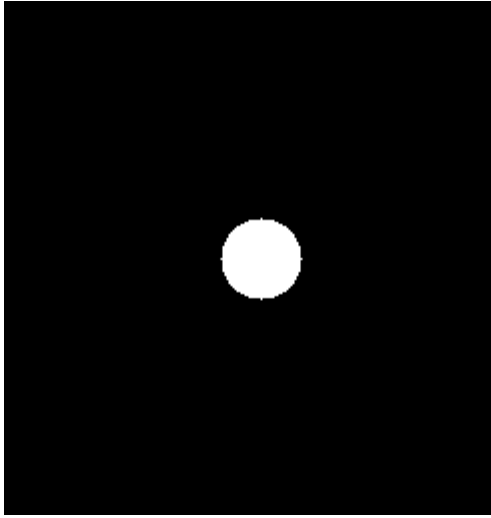
10 0		
Low pass filter without origin shifting n=2		
D	image	spectrum
10		
	ORIGIN_Butterworth_LPF_D0_10_n_2.png	ORIGIN_LPF_D0_10_n_2_SPRCTRM.png
20		


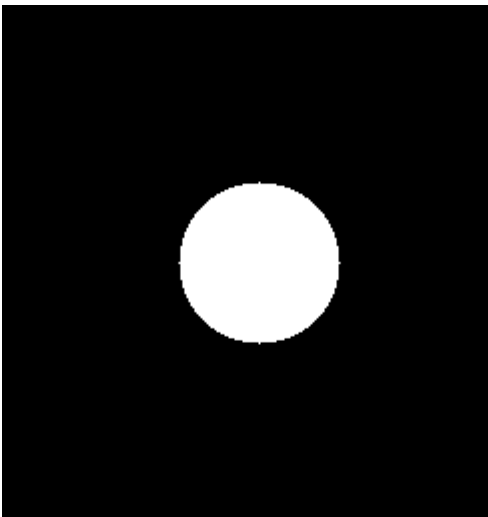
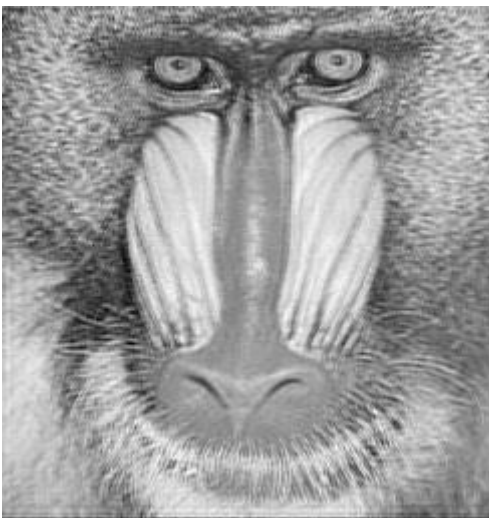
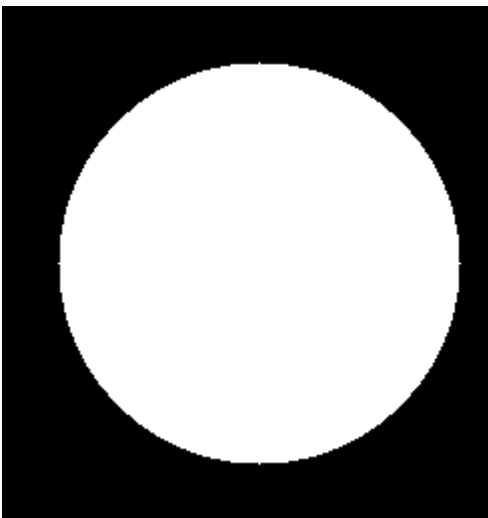

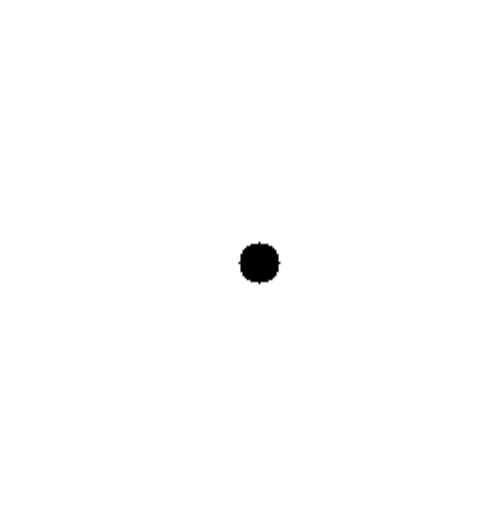
	ORIGIN_Butterworth_LPF_D0_20_n_2.png	ORIGIN_LPF_D0_20_n_2_SPRCTRUM.png
40		
	ORIGIN_Butterworth_LPF_D0_40_n_2.png	ORIGIN_LPF_D0_40_n_2_SPRCTRUM.png
100		
	ORIGIN_Butterworth_LPF_D0_100_n_2.png	ORIGIN_LPF_D0_100_n_2_SPRCTRUM.png
Low pass filter without origin shifting n=3		
D	image	spectrum



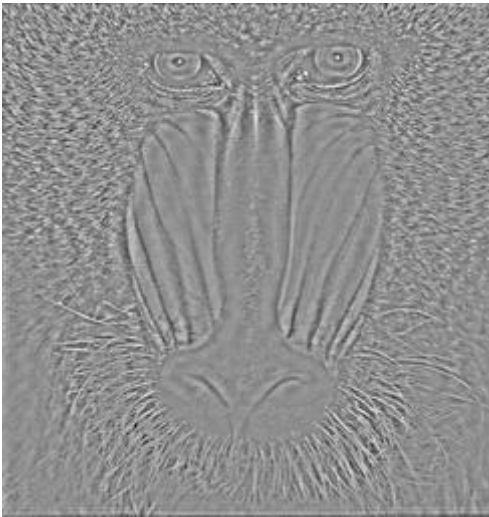

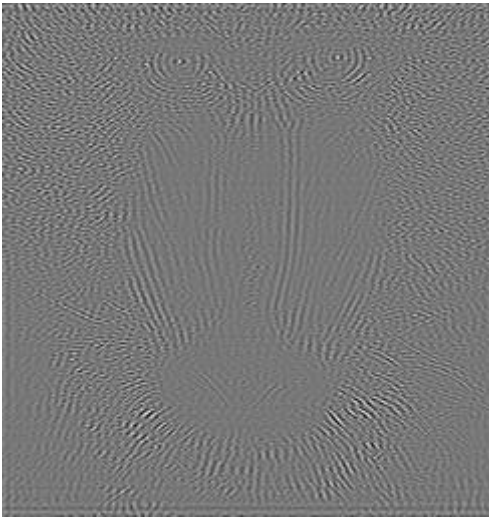
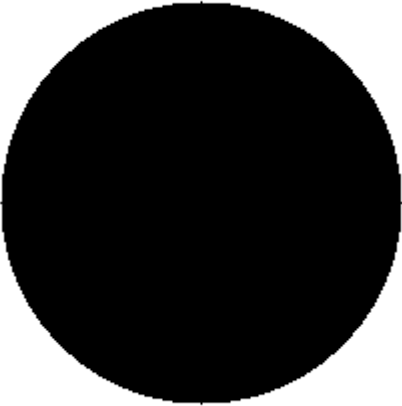
10	 <p data-bbox="368 728 794 763">ORIGIN_Butterworth_LPF_D0_10_n_3.png</p>	 <p data-bbox="879 728 1292 763">ORIGIN_LPF_D0_10_n_3_SPRCTRUM.png</p>
20	 <p data-bbox="368 1310 794 1346">ORIGIN_Butterworth_LPF_D0_20_n_3.png</p>	 <p data-bbox="879 1310 1292 1346">ORIGIN_LPF_D0_20_n_3_SPRCTRUM.png</p>
40	 <p data-bbox="368 1892 794 1915">ORIGIN_Butterworth_LPF_D0_40_n_3.png</p>	 <p data-bbox="879 1892 1292 1915">ORIGIN_LPF_D0_40_n_3_SPRCTRUM.png</p>

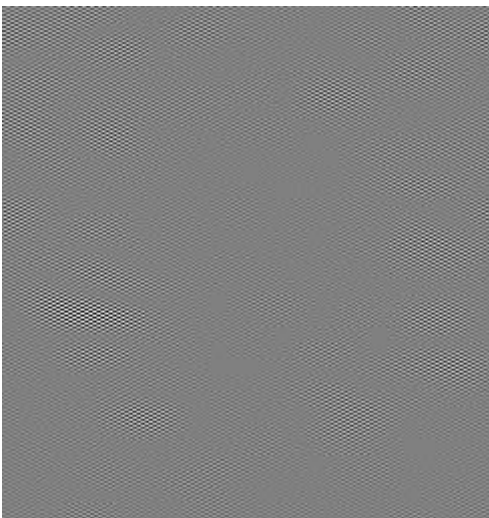
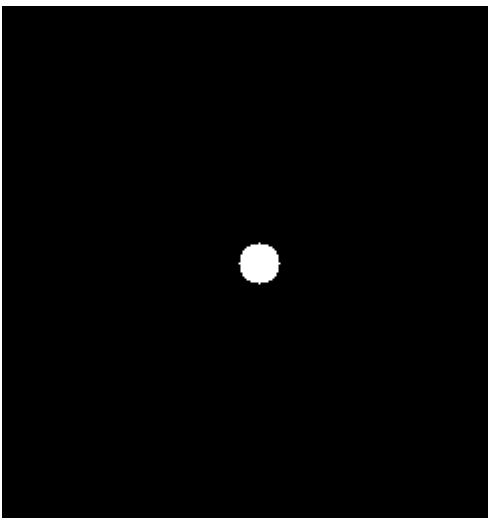
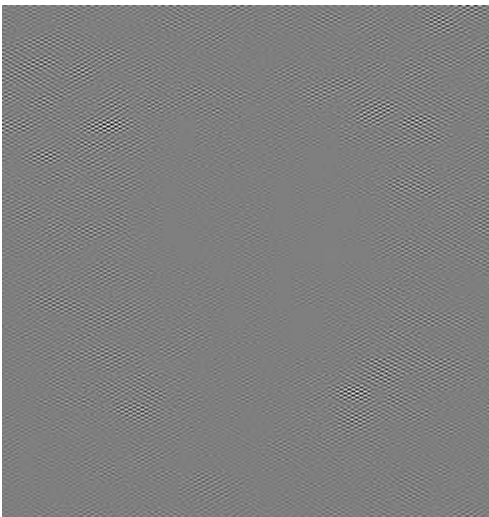
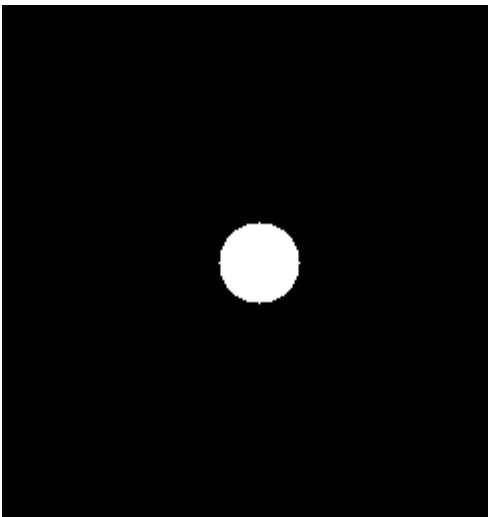
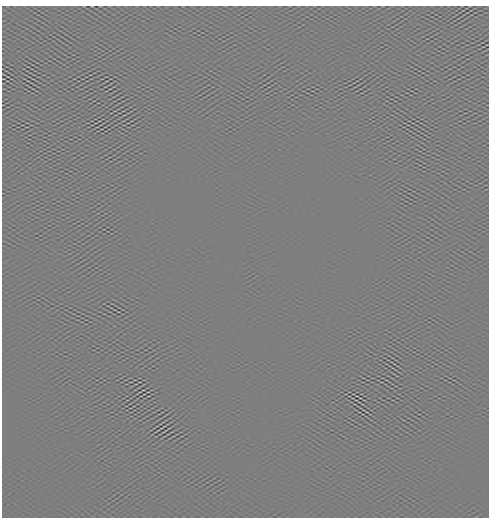
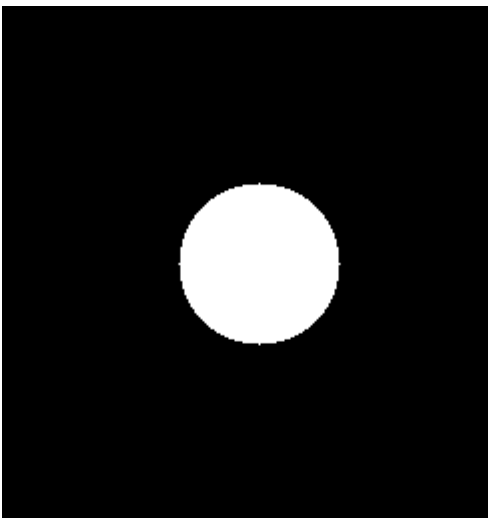
10 0		
Low pass filter without origin shifting n=4		
D	image	spectrum
10		
	ORIGIN_Butterworth_LPF_D0_10_n_4.png	ORIGIN_LPF_D0_10_n_4_SPRCTUM.png
20		


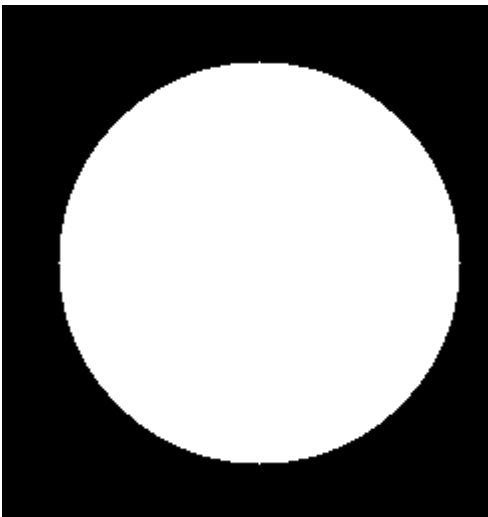
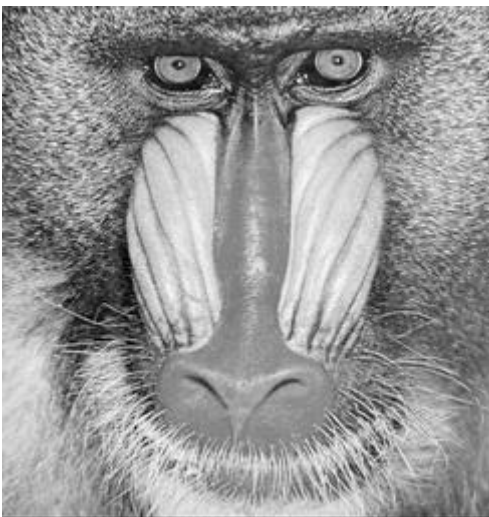
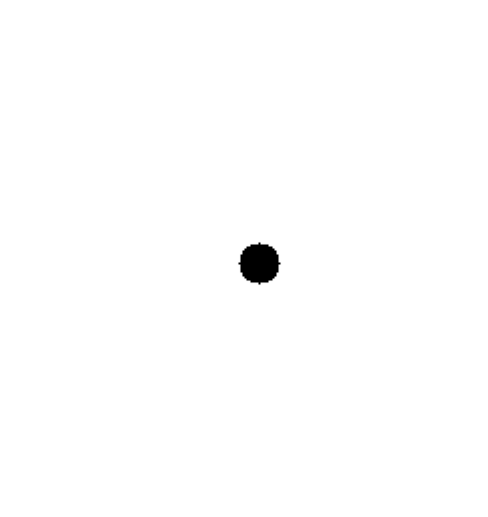
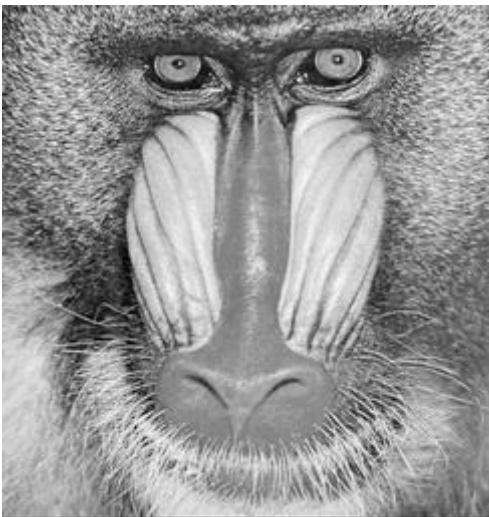
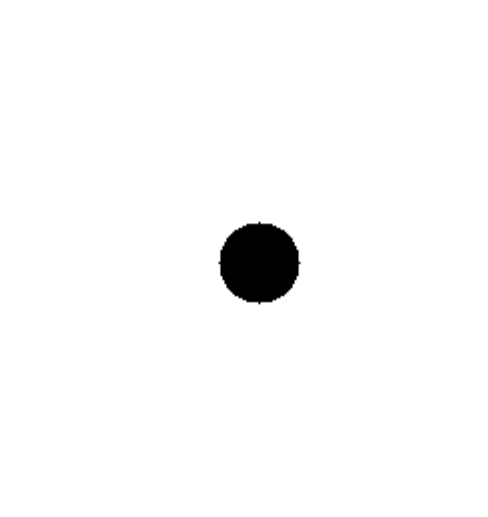
	ORIGIN_Butterworth_LPF_D0_20_n_4.png	ORIGIN_LPF_D0_20_n_4_SPRCTRUM.png
40		
	ORIGIN_Butterworth_LPF_D0_40_n_4.png	ORIGIN_LPF_D0_40_n_4_SPRCTRUM.png
100		
	ORIGIN_Butterworth_LPF_D0_100_n_4.png	ORIGIN_LPF_D0_100_n_4_SPRCTRUM.png
Discussion		
<p>可以發現沒有做 Origin shift 的版本作用是在高頻上因此跟我們的預期結果會相反，著重討論在經過 origin shift 我們常見的正常版本中 D0 的大小取決於應用需求。較小的 D0 適用於平滑圖像，而較大的 D0 適用於保留細節並強調邊緣，選擇 N 的大小可以根據應用的要求進行調整。較大的 N 適用於需要更陡的減弱的情況，例如對噪聲的高度抑制，LPF 圖像平滑、去除噪聲、模糊化等應用場景，HPF 邊緣增強、特徵提取、去除平均背景等應用場景，總的來說，Butterworth 濾波器的 D0 大小和 N 大小的設定會影響濾波器的截止頻率和過渡區域的行為，這對於平滑、去噪或強調特定頻率成分都至關重要。同時，選擇是使用低通濾波器還是高通濾波器，取決於應用的特定需求，因此題圖片數量較多另有開資料夾在 image_file 中的 butterworth 資料夾內</p>		

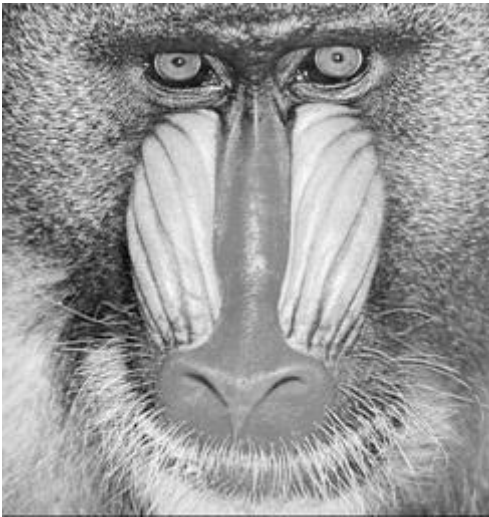

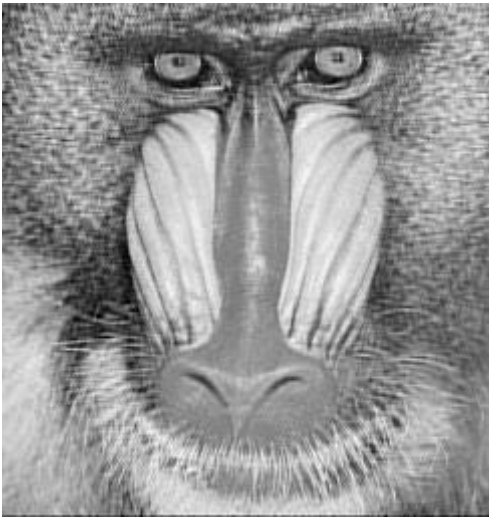
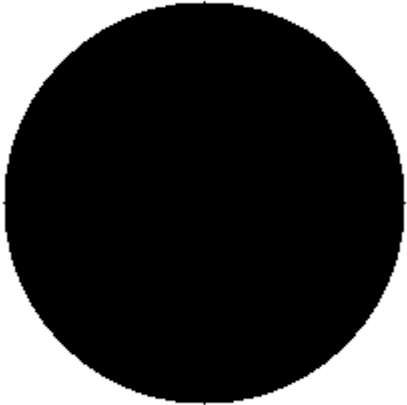
2.3		
Figure		
Low pass filter without origin shifting		
D	image	spectrum
10	 <p>ORIGIN_Idealfilter_LPF_D0_10.png</p>	 <p>ORIGIN_LPF_D0_10_SPRCTRUM.png</p>
20	 <p>ORIGIN_Idealfilter_LPF_D0_20.png</p>	 <p>ORIGIN_LPF_D0_20_SPRCTRUM.png</p>

40	 <p>ORIGIN_Idealfilter_LPF_D0_40.png</p>	 <p>ORIGIN_LPF_D0_40_SPRCTRUM.png</p>
100	 <p>ORIGIN_Idealfilter_LPF_D0_100.png</p>	 <p>ORIGIN_LPF_D0_100_SPRCTRUM.png</p>
High pass filter without origin shifting		
D	image	spectrum
10		

	ORIGIN_Idealfilter_HPF_D0_10.png	ORIGIN_HPF_D0_10_SPRCTRUM.png
20		
	ORIGIN_Idealfilter_HPF_D0_20.png	ORIGIN_HPF_D0_20_SPRCTRUM.png
40		
	ORIGIN_Idealfilter_HPF_D0_40.png	ORIGIN_HPF_D0_40_SPRCTRUM.png
100		
	ORIGIN_Idealfilter_HPF_D0_100.png	ORIGIN_HPF_D0_100_SPRCTRUM.png

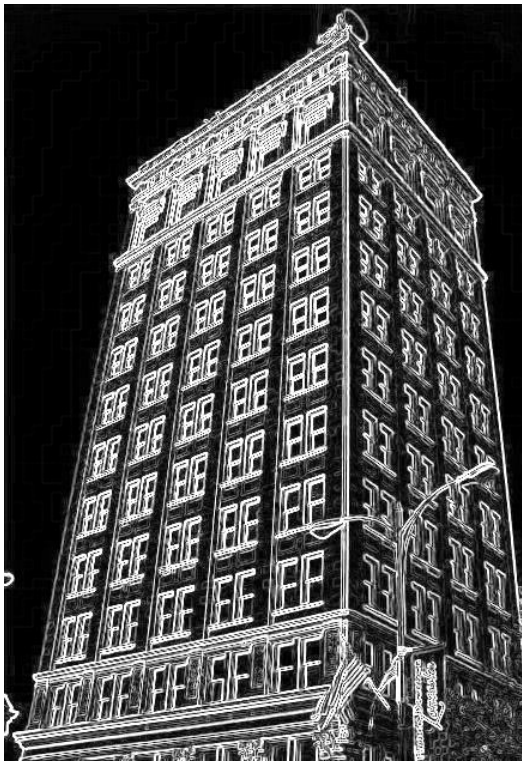
Low pass filter with origin shifting		
D	image	spectrum
10	 <p>Idealfilter_LPF_D0_10.png</p>	 <p>LPF_D0_10_SPRCTRUM.png</p>
20	 <p>Idealfilter_LPF_D0_20.png</p>	 <p>LPF_D0_20_SPRCTRUM.png</p>
40	 <p>Idealfilter_LPF_D0_40.png</p>	 <p>LPF_D0_40_SPRCTRUM.png</p>

10 0		
Idealfilter_LPF_D0_100.png		
LPF_D0_100_SPRCTRUM.png		
High pass filter with origin shifting		
D	image	spectrum
10		
	Idealfilter_HPF_D0_10.png	HPF_D0_10_SPRCTRUM.png
20		

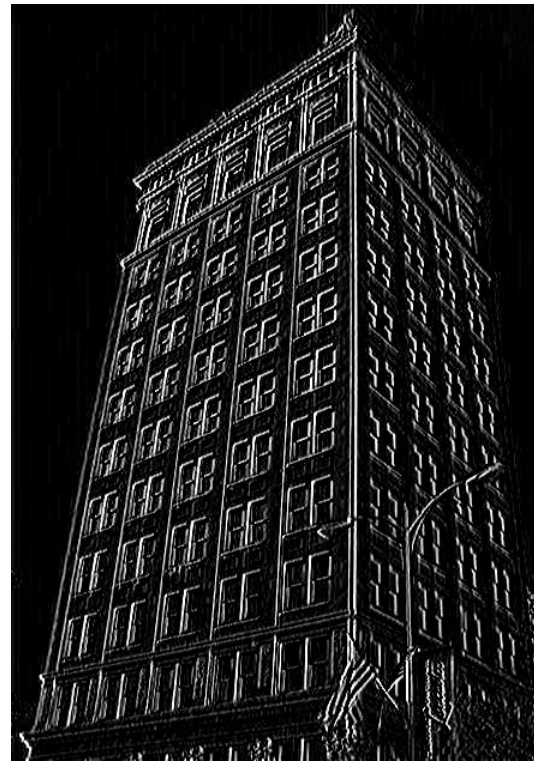
	Idealfilter_HPF_D0_20.png	HPF_D0_20_SPRCTRUM.png
40		
	Idealfilter_HPF_D0_40.png	HPF_D0_40_SPRCTRUM.png
100		
	Idealfilter__HPF_D0_100.png	HPF_D0_100_SPRCTRUM.png
Discussion		
<p>首先與前面問題一樣可以發現未做過 origin shifting 的結果愈預期部太相同、效果極差，同時可以發現 ideal filter 之所以叫 ideal 是因為在實際應用中有一些問題，如它的頻率響應在截止頻率處有不連續性，這可能導致實際實現時的一些問題。實際應用中常常使用其他濾波器，如巴特沃斯（Butterworth）濾波器或高斯(Gaussian)濾波器，這些濾波器在頻率響應方面更平滑，同時這題的照片也太多所以在 image_file 中多放一個資料夾 idealfilter 來儲存本題圖片。。</p>		

3.1

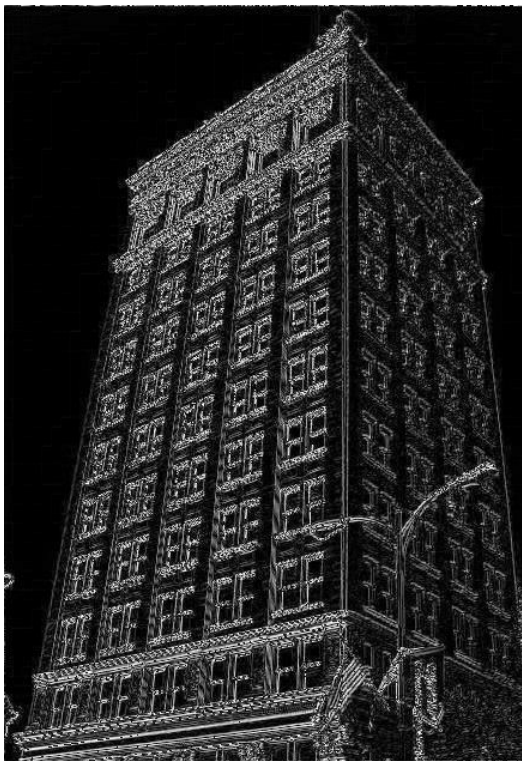
Figure



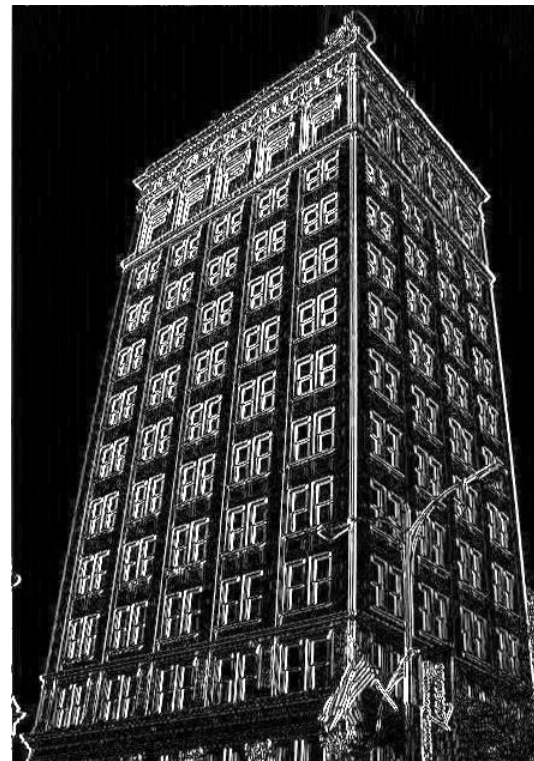
spetial_sobel_90_suilding.png



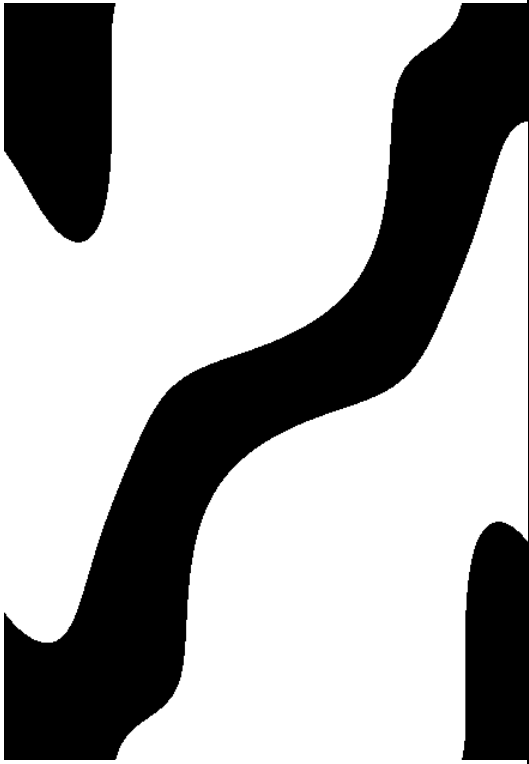
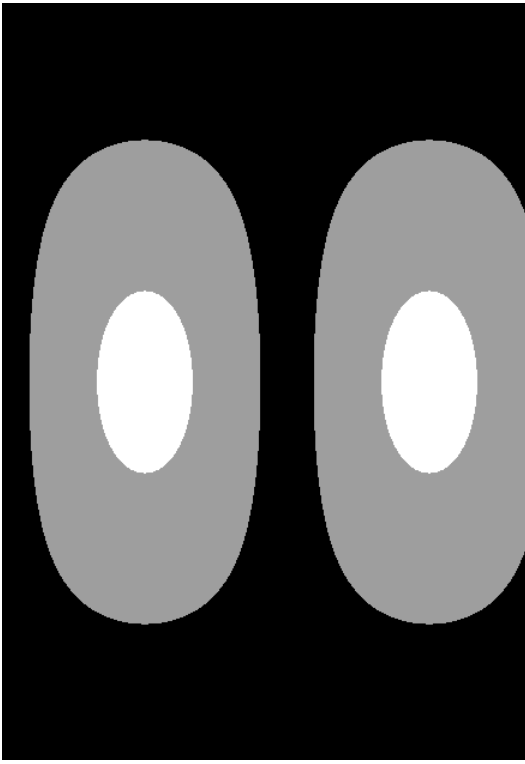
spetial_sobel_0_suilding.png



idft_sobel_90_building.png



idft_sobel_0_building.png

	
dft_sobel90.png	dft_sobel0.png
Discussion	
<p>在計算上 Spatial domain 的捲積速度比起 DFT 快上許多，但是考量到 FFT 的話會比起捲積更快，因此在 Frequency domain 上計算具有更多優勢，在視覺呈現上 Spatial domain 讓人眼能夠更直覺地看出效果，邊界處理上 Spatial domain 更為容易利用 mirroring、padding 的方式處理，Frequency domain 則較容易引起人為干擾的落差，這一題用自己手刻的方式而沒有採用 opencv，把原圖做完 DFT、Filter 用 3*3 並把他放到中間再把周圍用 0-padding 後丟入 DFT 並與原圖的 DFT 結果相乘，最後做 IDFT，在數值處理上 >255 則設為 255，<0 則設為 0，與原圖的落差可能來自較小的 filter、0-padding 有關。。</p>	