NTUT112-1 Digital Image Processing
Homework Assignment 3
Due Date: 12/13(Wed.) 2023

Question :

Try to run the following steps to learn how to process the Lena image (lena.bmp) in frequency domain. Try to design at least another one different parameter setting for the following highlighted commands and explain your results.

(TA: Please submit **a PDF file** containing your source code, the resulting images, and your explanation. Remember that you need to use at least another one different parameter setting for each following filter. Please name your PDF file as 'HW3_${your studentID}.pdf'. For example, if your student ID is 111598084, you will need to upload one files: 'HW3_111598084.pdf')

Display fft image in log

```
[x, map] = imread('lena.bmp');
xf = fftshift(fft2(x));
flog = log(1+ abs(xf));
fm = max(flog(:));
subplot(1,2,1)
image(x);
colormap(map), axis('square')
subplot(1,2,2)
image(flog*255/fm);
colormap(map), axis('square')
```

Display fft image in absolute value

```
[x, map] = imread('lena.bmp');
xf = fftshift(fft2(x));
fabs = abs(xf);
fm = max(fabs(:));
subplot(1,2,1)
image(x);
colormap(map), axis('square')
axis('square')
subplot(1,2,2)
image(fabs*255/fm);
colormap(map), axis('square')
```

Design image filter in frequency domain

1. Ideal Low-pass filter

```
% change size of z to view the differences of low pass filter
xLena=imread('lena.bmp');
xLenaf=fftshift(fft2(xLena));
flog = log(1+abs(xLenaf));
fm = max(flog(:));
fig = figure();
fig.Position(3:4) = [1000, 1500];
subplot(3,2,1)
image(xLena);
colormap(map), axis('square')
subplot(3,2,2)
image(flog*255/fm);
colormap(map), axis('square')
[x,y]= meshgrid(-256:255,-256:255);
z = sqrt(x.^2+ y.^2);
clf= (z<15);

subplot(3,2,4)
image(255*clf);
colormap(map), axis('square')

subplot(3,2,6)
yLenaf=xLenaf.*clf;
flog = log(1+abs(yLenaf));
fm = max(flog(:));
image(flog*255/fm);
colormap(map), axis('square')

yLena=ifft2(yLenaf);
subplot(3,2,5)
image(abs(yLena));
colormap(map), axis('square')
```

2. Ideal High-pass filter

```
% change size of z to view the differences of high pass filter
fig = figure();
fig.Position(3:4) = [1000, 1500];
subplot(3,2,1)
image(xLena);
colormap(map), axis('square')

subplot(3,2,2)
flog = log(1+abs(xLenaf));
fm = max(flog(:));
image(flog*255/fm);
```

```
colormap(map), axis('square')

[x,y]=meshgrid(-256:255,-256:255);
z=sqrt(x.^2+y.^2);
chf=(z>15);

subplot(3,2,4)
image(255*chf);
colormap(map), axis('square')

yLenaf=xLenaf.*chf;
flog = log(1+abs(yLenaf));
fm = max(flog(:));
subplot(3,2,6)
image(flog*255/fm);
colormap(map)

yLena=ifft2(yLenaf);
subplot(3,2,5)
image(abs(yLena));
colormap(map), axis('square')
```

3. Butterworth low-pass filter (blf)

```
% change size of D and n to view the differences of Butterworth low-pass filter
fig = figure();
fig.Position(3:4) = [1000, 1500];
subplot(3,2,1)
image(xLena);
colormap(map), axis('square')

subplot(3,2,2)
flog = log(1+abs(xLenaf));
fm = max(flog(:));
image(flog*255/fm);
colormap(map), axis('square')

%D=15, n=2
D=15;
n=2;
[x,y]=meshgrid(-256:255,-256:255);
blf=1./(1+((x.^2+y.^2)/D).^n);
subplot(3,2,4)
image(255*blf);
colormap(map), axis('square')

yLenaf=xLenaf.*blf;
flog = log(1+abs(yLenaf));
fm = max(flog(:));
subplot(3,2,6)
```

```
image(flog*255/fm);
colormap(map), axis('square')

yLena=ifft2(yLenaf);
subplot(3,2,5)
image(abs(yLena));
colormap(map), axis('square')
```

4. Butterworth high-pass filter (bhf)

```
% change size of D and n to view the differences of Butterworth high-pass filter
fig = figure();
fig.Position(3:4) = [1000, 1500];
subplot(3,2,1)
image(xLena);
colormap(map), axis('square')

subplot(3,2,2)
flog = log(1+abs(xLenaf));
fm = max(flog(:));
image(flog*255/fm);
colormap(map), axis('square')

%D=15, n=2
D=15;
n=2;
[x,y]=meshgrid(-256:255,-256:255);
blf=1./(1+((x.^2+y.^2)/D).^n);
bhf=1-blf;
subplot(3,2,4)
image(255*bhf);
colormap(map), axis('square')

yLenaf=xLenaf.*bhf;
flog = log(1+abs(yLenaf));
fm = max(flog(:));
subplot(3,2,6)
image(flog*255/fm);
colormap(map), axis('square')

yLena=ifft2(yLenaf);
subplot(3,2,5)
image(abs(yLena));
colormap(map), axis('square')
```

5. Gaussian Low-Pass Filter (glf)

```
 % change size of std (standard deviation) to view the differences of Gaussian low-pass filter / Gaussian high-pass filtering
 fig = figure();
 fig.Position(3:4) = [1000, 1500];
 subplot(3,2,1)
 image(xLena);
 colormap(map), axis('square')

 subplot(3,2,2)
 flog = log(1+abs(xLenaf));
 fm = max(flog(:));
 image(flog*255/fm);
 colormap(map), axis('square')

 gsize=512;
 std =60;
 [x,y] = meshgrid(-256:255,-256:255);
 arg  = -(x.*x + y.*y)/(2*std*std);
 glf = exp(arg);
 glf(glf<eps*max(glf(:))) = 0;
 %sumh = sum(glf(:));
 %if sumh ~= 0,
 %glf =glf/sumh;
 %end;

 subplot(3,2,4)
 image(255*glf);
 colormap(map), axis('square')

 yLenaf=xLenaf.*glf;
 flog = log(1+abs(yLenaf));
 fm = max(flog(:));
 subplot(3,2,6)
 image(flog*255/fm);
 colormap(map), axis("square")

 yLena=ifft2(yLenaf);
 subplot(3,2,5)
 image(abs(yLena));
 colormap(map),axis('square')
```