Practical works – n^{o}5
2D - Discrete Fourier Transform

• **Exercice 1** – *2D - DFT*

1.1 Consider an synthetic image as following:

```
img = zeros(301,301);
img(100:200, 140:160) = 255;
figure(1);
imshow(img);
```

1.2 we can compute the FFT as follows:

```
imgFreq = fftshift(fft2(img));
figure(1);
subplot(121); imagesc(abs(imgFreq)); colormap('gray'); title('Magnitude')
subplot(122); imagesc(angle(imgFreq)/pi*180); colormap('gray'); title('Phase')
```

1.3 Compute the FFT of translated, rotated and other versions of the synthetic image and illustrate the magnitude and phase of the frequency response.
Discuss your observations.

```
img = zeros(301,301);
img(100:200, 140:160) = 255;
imgTrans = zeros(301,301);
imgTrans(150:250, 160:180) = 255;
imgRot = imrotate(img, 45)
img2 = zeros(301,301);
img2(20:120, 140:160) = 255;
img2(180:280, 140:160) = 255;
img3 = zeros(301,301)
img3(100:200, 145:155) = 255
```

1.4 Lets consider another synthetic image as follows, compute the phase and the magnitude of the following image and display the normalized center frequency.

```
Im=0;
N=64;
T=1;
Ts=T/N;
Fs=1/Ts;
df=Fs/N;
Im(N/8:N/4,N/4+1:N/2)=1;
Im(1:N/4,N/2+1:N)=Im;
Im(N/4+1:N/2,:)  = Im;
Im(N/2+1:3*N/4,:)  = Im(1:N/4,:);
Im(3*N/4+1:N,:)  = Im(1:N/4,:);
```

1.5 Plot $|I_f(u,0)|$ and $|I_f(0,v)|$ with the correct frequency range. Discuss your observaton.

1.6 Load the "lena" image, and show the phase and magnitude, then reconstruct the image using either frequency or phase.

1.7 Apply the sobel filter only in vertical direction to 'lena' image in the frequency domain.

In order to build a frequency filter $H(u,v)$ from its spatial counterpart $h(x,y)$, we need to:

1. Build a zero padded spatial filter $h_p(x,y)$
2. Shift $h_p(x,y)$ by $(-1)^{x+y}$

3. Compute the DFT to obtain $H(u, v)$
4. Shift $H(u, v)$ by $(-1)^{x+y}$

In order to aboid the wraparound error, the image need to be zero padded In order to perform the filtering, we need to:

1. Find the padded image size
2. Pad the image
3. Convert the spatial filter to frequency filter
4. Compute the DFT of the image with additional shift
5. Apply the multiplication in the Fourier space
6. Compute the inverse Fourier transform
7. Crop the image at its original size