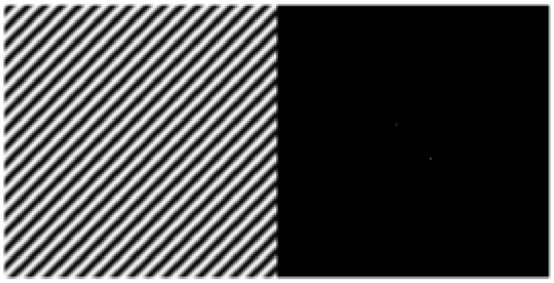
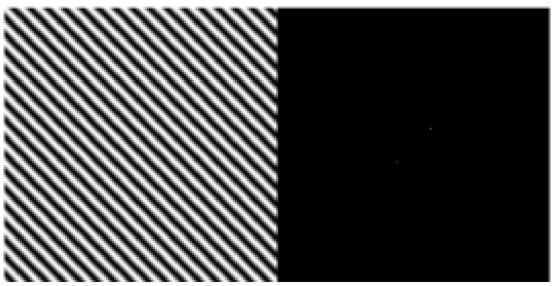
EE475 HW#4 Sezen Perçin

2D Sinusoids

A) The image of $cos[2\pi(8x/128 + 8y/128)]$ and its spectrum:



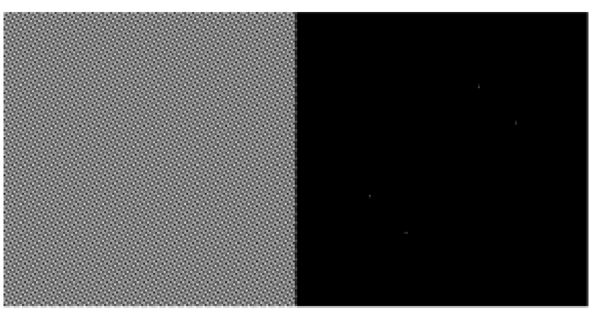
B) The image of $cos[2\pi(8x/128 - 8y/128)]$ and its spectrum:



In 1D cos function is an even function with respect to x (cos(x)= cos(-x)) but this is not the case when it is in 2D as it is with the images.

A sign transformation in the variables affects the image by changing its time domain values and frequency domain value. Therefore in the left, the image is the symmetry of the first one with respect to y axis and its spectrum also the symmetry of the first one w.r.t. v axis.

C) The image of $cos[2\pi(8x/128 - 8y/128)]$ $cos[2\pi(24x/128 - 24y/128)]$ and its spectrum:

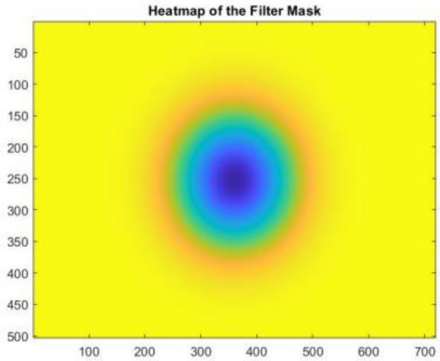


Since it is a multiplication in the time domain the image is the multiplication of the to cos function value and one of them has the -y component therefore the plots are interwined.

Multiplication in one domain means convolution in the other. The value of the frequencies are larger in the $cos[2\pi(24x/128 - 24y/128)]$ function therefore their convolution got far away from the center.

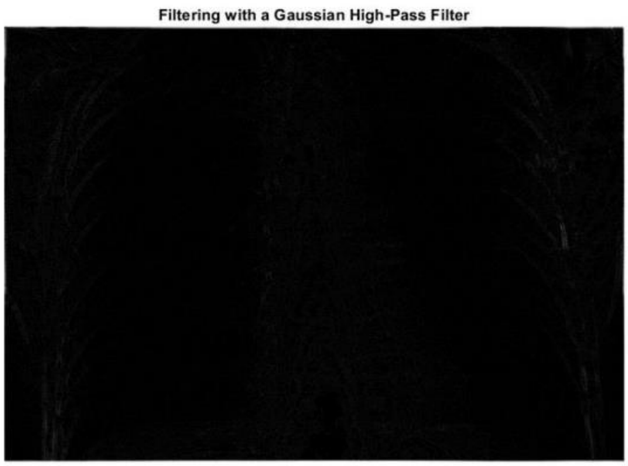
Unsharp Masking and High-Boost Filtering:

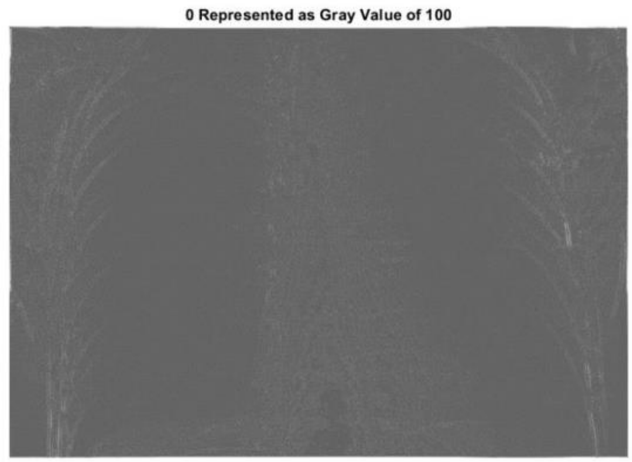
a)



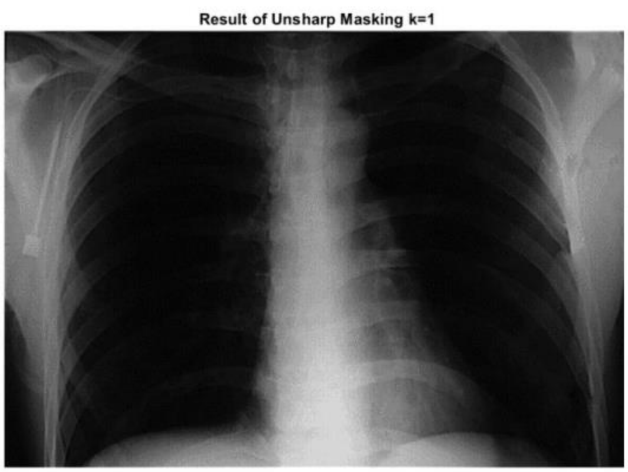
Since we can choose D0 as the %5-10 of the long image dimension, I chose it to be D0= %10.720=72.

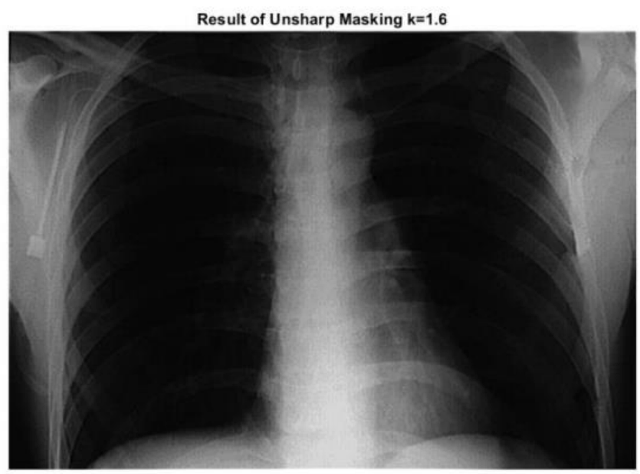
b)



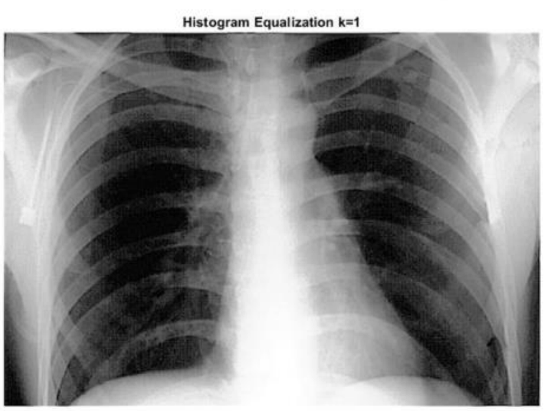


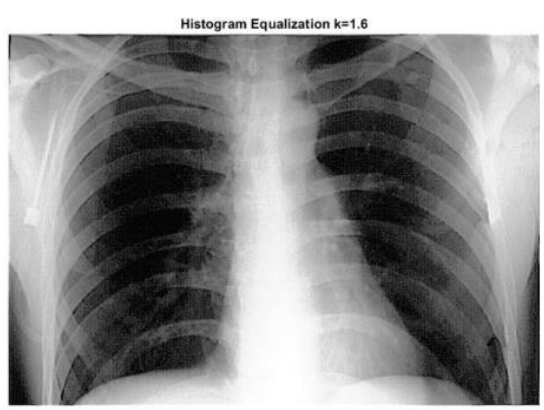
c)





d)

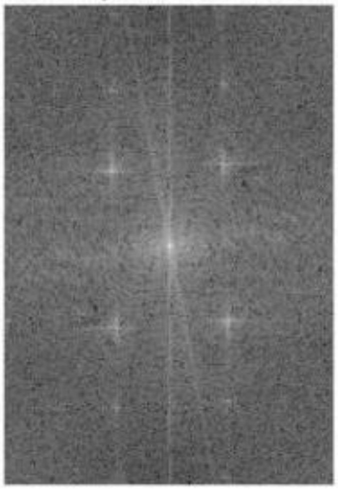




Moiré Noise Removal

a)

Magnitute Spectrum of the Image



b) I chose the peaks and their diameters where the peak value is decreased to it 1/sqrt(2) value interactively on the magnitude spectrum on the left. The peak points (x,y) and diameters (taking the image center as (0,0)):

H1: peak at (-28.5,37.5) , d0=18

H2: peak at (28.5,-37.5) , d0=18

H3: peak at (-26.5,-42.5) , d0=16

H4: peak at (26.5,42.5) , d0=16

H5: peak at (-26.5,-83.5) , d0=8

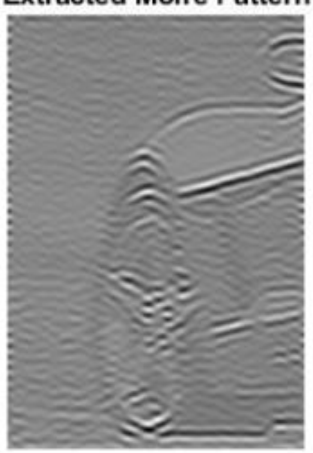
H6: peak at (26.5,83.5) , d0=8

H7: peak at (30.5,-79.5) , d0=10

H8: peak at (-30.5,79.5) , d0=10

c)

Extracted Moire Pattern



d)

Filter Spectrum With the Moire Noise Components Eliminated

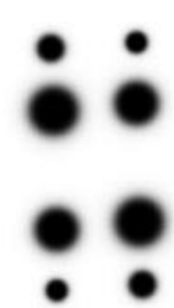


Image Without the Moire Noise

From Probs. 4.51, 4.52

a) Due to properties of the DFT, we know that:

$$\frac{\partial^m}{\partial t^m} f(t,z) \Leftrightarrow (j2\pi\mu)^m F(\mu,\nu) \quad \text{and} \quad \frac{\partial^n f(t,z)}{\partial z^n} \Leftrightarrow (j2\pi\nu)^n F(u,v)$$

We also know that Laplacian of a function is defined as:

$$\nabla^2 f(x,y) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

Then we can calculate the components as:

$$\frac{\partial^2 f(x,y)}{\partial x^2} \Leftrightarrow (j2\pi u)^2 F(u,v)$$

$$\frac{\partial^2 f(x,y)}{\partial y^2} \Leftrightarrow (j2\pi v)^2 F(u,v)$$

Therefore

$$\mathcal{F}\{\nabla^2 f(x,y)\} = (j2\pi)^2 F(u,v)\,(u^2+v^2)$$
$$= -4\pi^2 (u^2+v^2) F(u,v)$$