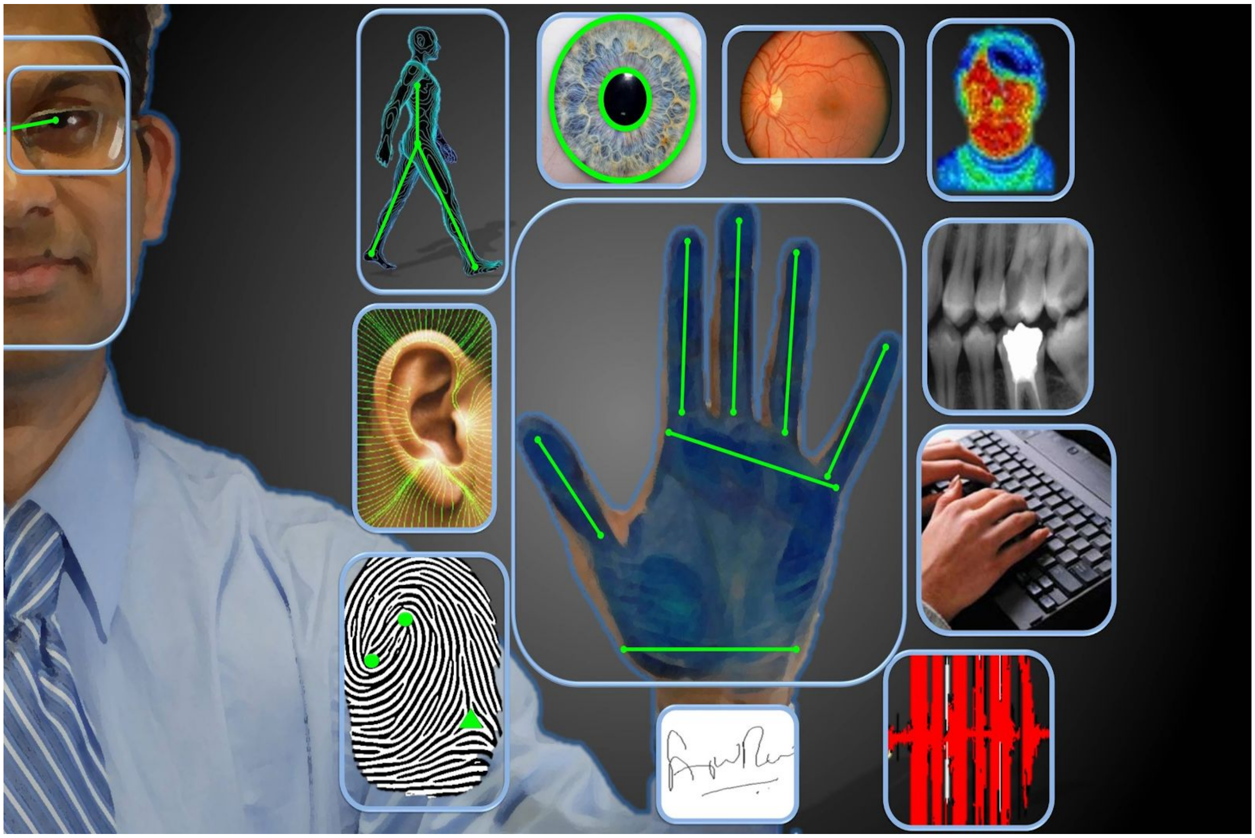

Digital Image Processing

Assignment-3

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20161054

Question-1:

Part-1)

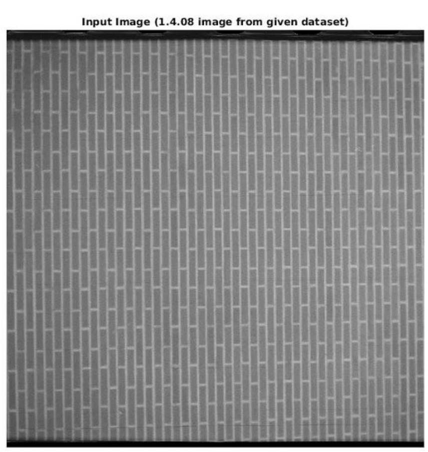
Range transformation used here is a "log() transformation".

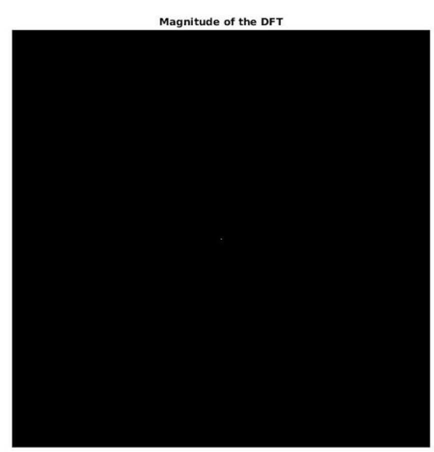
image(i,j) = log(image(i,j)+1);

As the range of the Fourier coefficients is very large. So they don't fall in the intensity range , It is difficult to display on screen. That is why when we display Fourier transform without transformation will result in showing all black or white values.

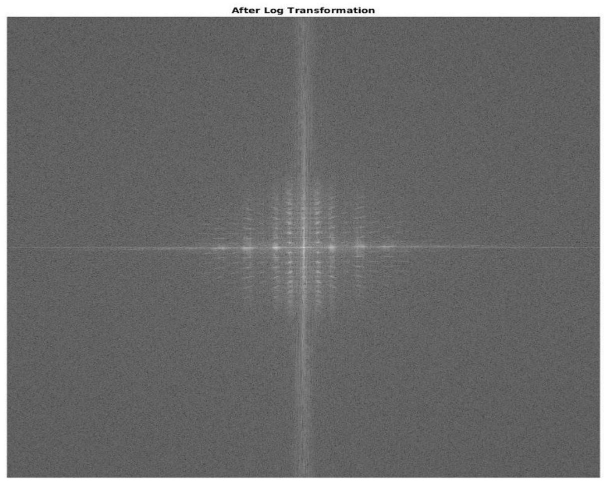
So taking the above Log transformation will give the Intensities in our required range.

Magnitude of DFT:



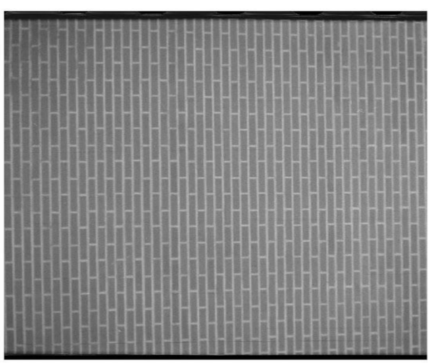


After the Log transformation



Part- 2)

Log transformation enhances the low intensity pixel values while compressing the high intensity pixel values into a small pixel range.



Part-3)

The difference is as follows..

“abs(fft2(fft2(img)))” gives the reflection of image about center of the image.

Results are followed..

We can handle this easily in frequency domain by

“Applying the fft again two times gives the original image back

I,e. Totally apply fft 4 times on the image to get original image”.

fft2(fft2(fft2(fft2(image)))).

This gives the original image back as it..

Question-2:

As we can see that the RIGHT image is the “Reflection about CENTER of LEFT image ”.

Let assume f(x,y) be the image.

$$f(x,y) = (-1)^{(x+y)} f(x,y)$$

Complex conjugate means that the replacing the “j” with “-j” in the inverse transformation.

So, it as follows..

$$F^{-1}(F^*(u, v)) = \sum\sum F(u, v)\ e^{-j2\pi(ux/M + vy/N)}$$

$$= \sum\sum F(u, v)\ e^{j2\pi(u(-x)/M + v(-y)/N)}$$

$$= \ f(-x, -y)$$

So, from above proof we can conclude that the resultant image is the reflection of the original image about origin.

Question-3:

DFT….

dft(Image)

$$F(u,v) = \sum \sum f(x,y)\, e^{-j2\pi(ux/M + vy/N)}$$

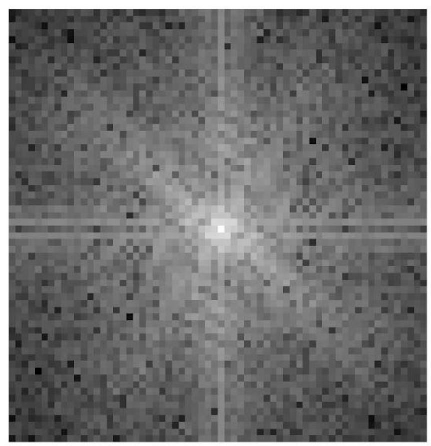
As the padding increases the resultant fourier transform becomes much clearer.

The reason might be because , the image space is increased keeping the content constant, whereas fft of a 64x64 our image array gives a 64x64 fft array which contains the peaks , Or intensity distribution within the images.

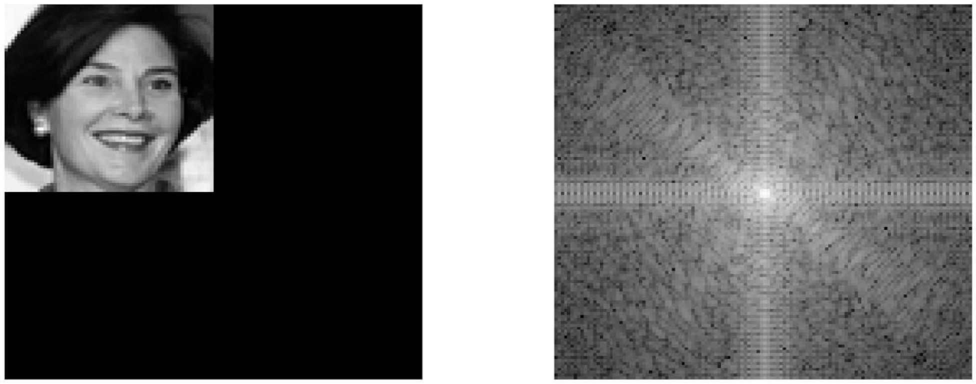
So,if padding is done on right and bottom of image then fft of image along rows and columns of padded will have only a zero frequency component, It results the fft with same content in more range so it will be much clearer i.e; if FFTIM is output of 64*64 image initially , padded with A rows and columns on right and bottom respectively the resultant fft of transformed image will be of size (64+A)*(64+A) but the content in the fft was same as 64*64 but it's scope has been increased which makes the fft image much clearer.

Follow are the images with whose fft's are centered….

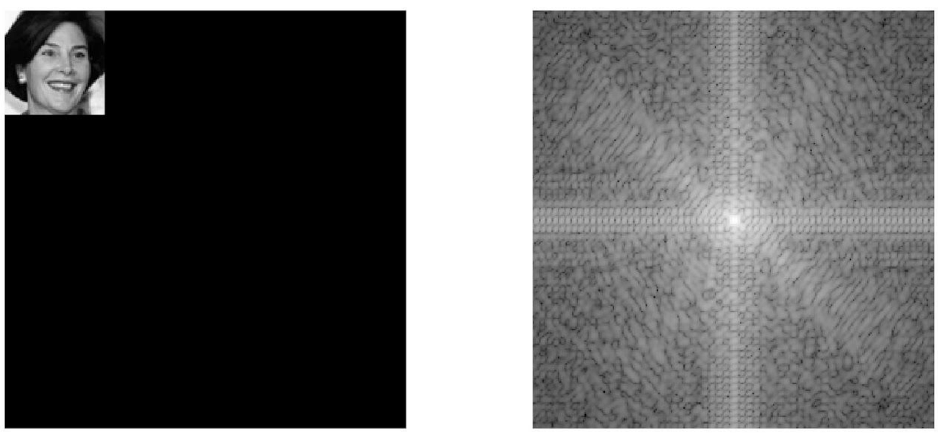
64x64 ……………>



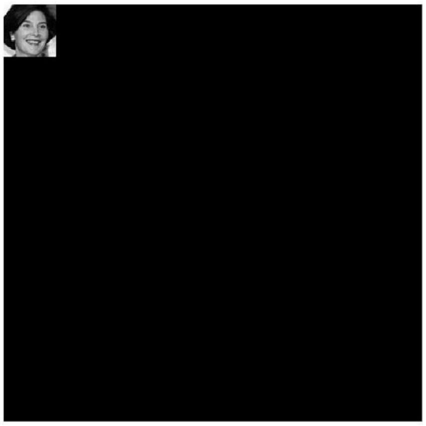
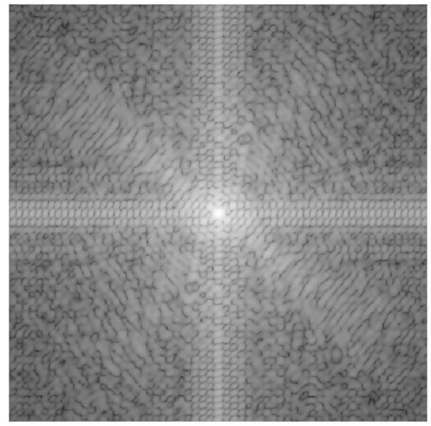
128x128 ………….>



256x256 ………..>



512x512 ……..>

Question-4:

Part-1)

Taken images are

(f)**cameraman.tif** and (h)**rice.png** each of size [256, 256].

iDFT2(FH) ----> [256, 256] where F =fft2(f), H =fft2(h);

f*h ----> [511, 511]

Center portion of f*h is f*h(128:383, 128:383);

It does NOT correspond to the iDFT2(FH)

Avg of Squared Differences between them is **1.7776e+17**

Part-2)

Taken image are

(f)cameraman.tif ---> [256,256] and

(h)grayimagefor4.png ---> [200, 150].

Verifying the Convolution Theorem

$$\mathrm{DFT}[f * h] = \mathrm{FzHz},$$

where Fz and Hz are the 2D-DFT of the images fz, hz, with fz; hz being the images f and h,with appropriate.

zero-padding

From the result of verification we get that RHS and LHS of an images are almost same

Avg of Squared Differences between them is 1.8272e-10

This may ignored and as treat both are same.

Part-3)

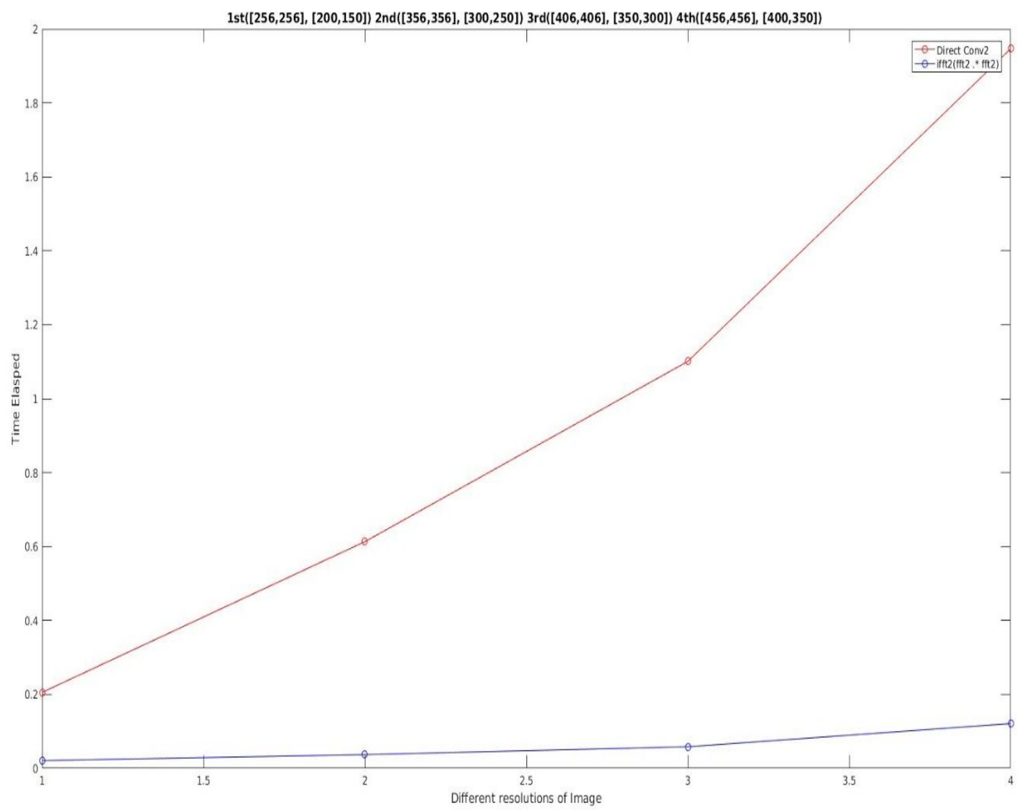
After calculating the times required by direct convolution and using DFT, we noticed the following obsevation..

As we increasing the dimensions of the taken images (f, h),

-Time required for Direct Convolution is increasing exponentialy.

-Time required for Convolution Using DFT is increasing linearly with less slope.

Plot of times with different dimensions..



Part-4)

Taken images are

(f)**cameraman.tif** and (h)**rice.png** each of sizes [256, 256].

For f∗h using DFT, we need to zero-pad each array to be of size 511 × 511 and compute the DFTs of these 511 × 511 arrays. And take inverse DFT.

Time consumed for zero-padded images of size 511x511 is Equal to **0.0394** seconds.
Time consumed for zero-padded images of size 512x512 is Equal to **0.0105** seconds.

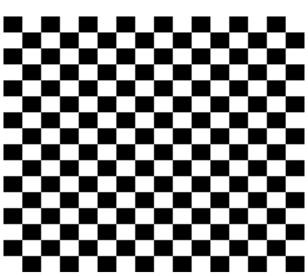
The values outside the 511x511 sub-array are not zeros practically, But there are very small in the order of 10^-7.
Min value outside 511x511 subarray : **-1.4901e-07**
Max value outside 511x511 subarray : **1.3411e-07**

They may be considered as zeros practically.

Question-5:

n_x , n_y are spatial sampling frequencies… for sampling the given chess board image , Our goal is to find the Highest sampling frequency Nx, Ny for reconstruction of image without loss of information.

Each row and column has 16 cells(8 Black and 8 White)..



As a general observation we need atleast one pixel value from the each small cell for better reconstruction of the image back.

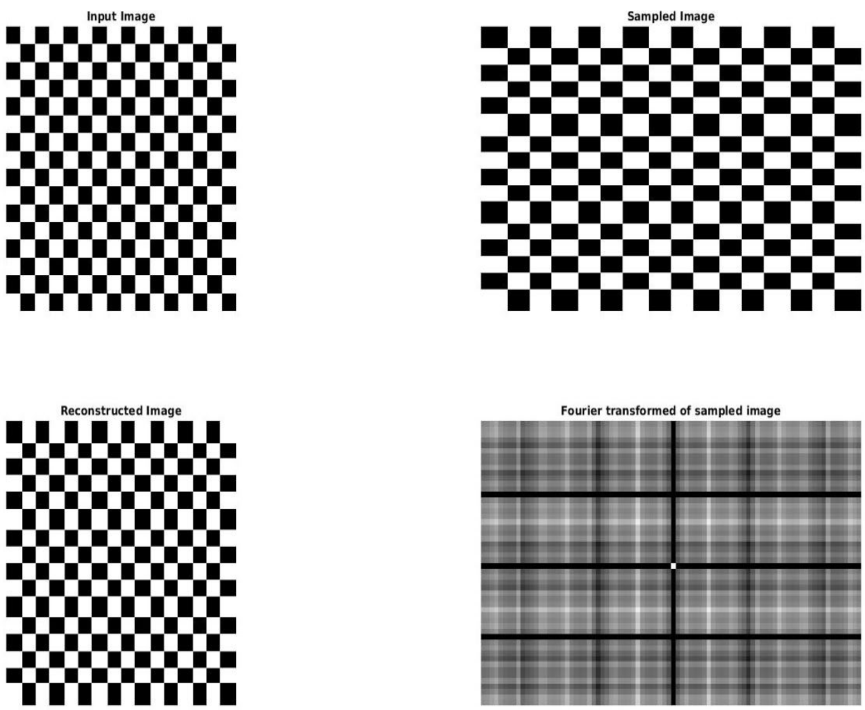
From the following results we conclude that the sampling frequencies for better reconstruction of image is the

Nx, Ny must be multiples of 2 and must less than 16

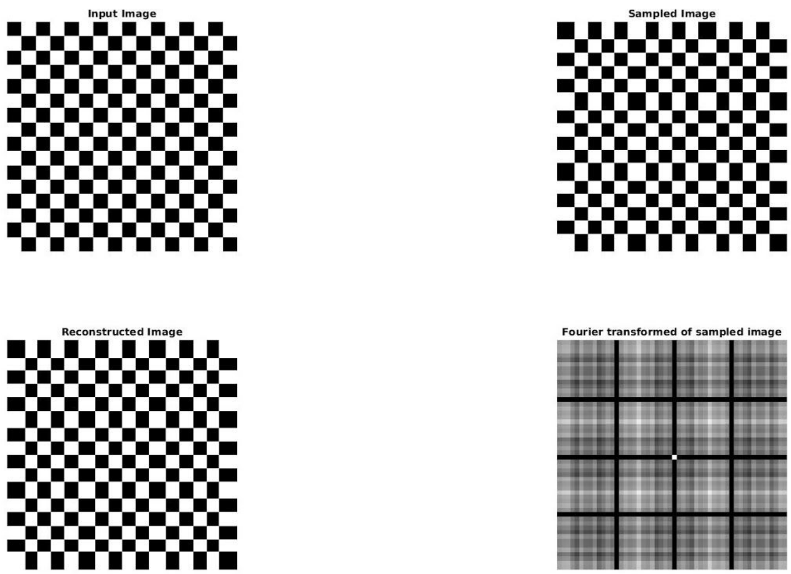
Highest Sampling frequencies will be Nx=16, Ny=16.

Results are following for different nx, ny values.

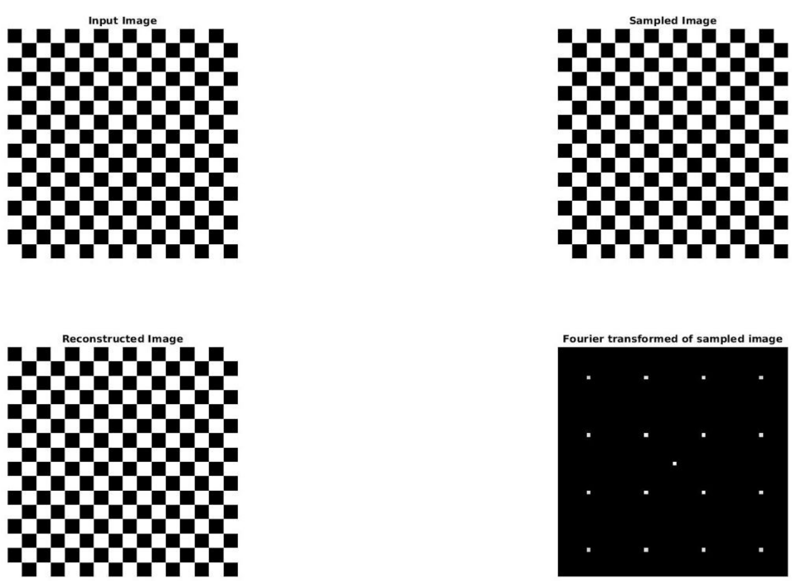
nx=5, ny=3



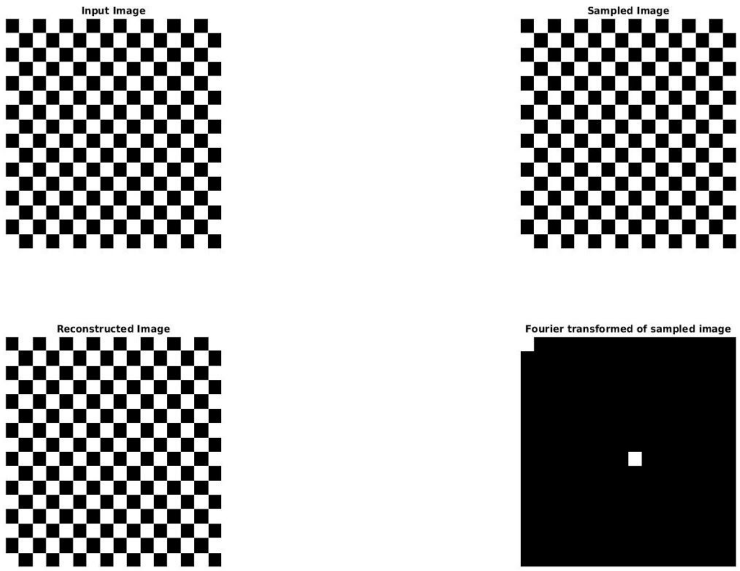
nx=5 , ny=5



nx=4, ny=4



nx=16, ny=16,



nx=32,ny=32,