Project #1

Problem Statement:

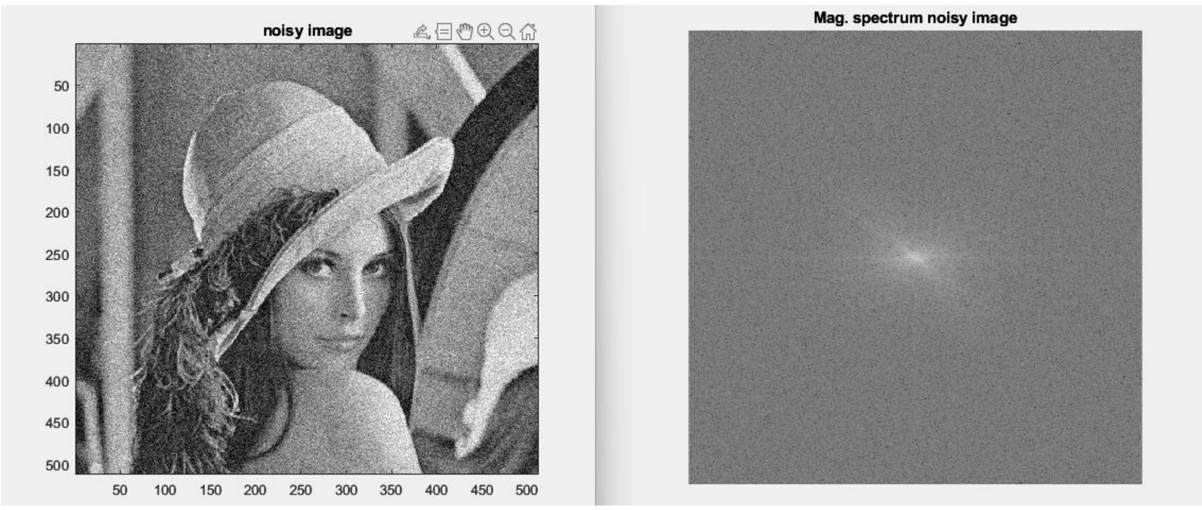
You will be working with the 512X512, 8-bit-per-pixel, “lena512noisy.bmp” image posted on Canvas.
Wavelet Image Denoising

Create two image denoising systems using the 2-D SWT via the following steps:
(1) Decompose the “lena512noisy.bmp” image into subbands using 16-band dyadic (pyramid) decomposition and 22-band modified pyramid (i.e., the image is initially decomposed into 16 equal-sized subbands, with two additional levels of decomposition being applied to the lowest-frequency subband) schemes. Use any SWT filter in MATLAB and make sure you eliminate the edge effects.

(2) For the dyadic case, set the highest-frequency, three highest-frequency, and six highest-frequency subbands to zero, and leave the remaining coefficients unchanged. For the modified pyramid case, set the three highest-frequency, 10 highest-frequency, and 15 highest-frequency subbands to zero, and leave the remaining coefficients unchanged. Form the reconstructed image in each case by taking the inverse SWT after setting the appropriate coefficients to zero. For each case, display the reconstructed image and comment on its perceived quality.

(3) For each case, including the original input image, plot the 2-D DFT magnitude spectrum of each reconstructed image and comment.

Observations:

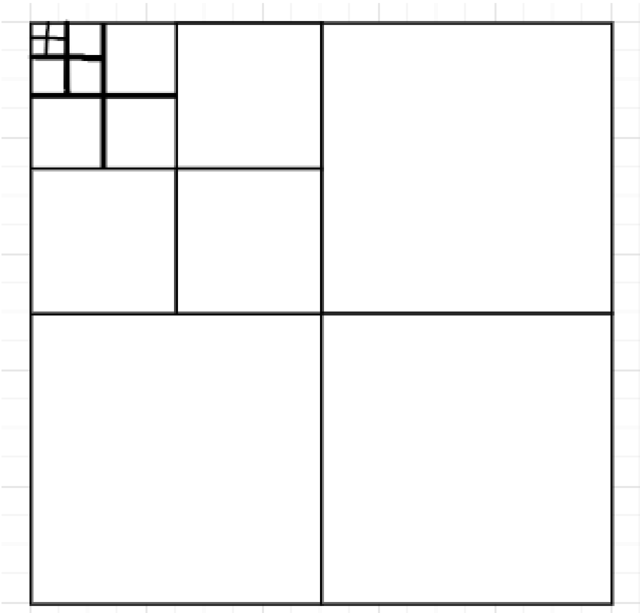


Original Image and its Corresponding DFT

Above is the original Image with corresponding 2D DFT of the image.

16 Band Dyadic Decomposition:

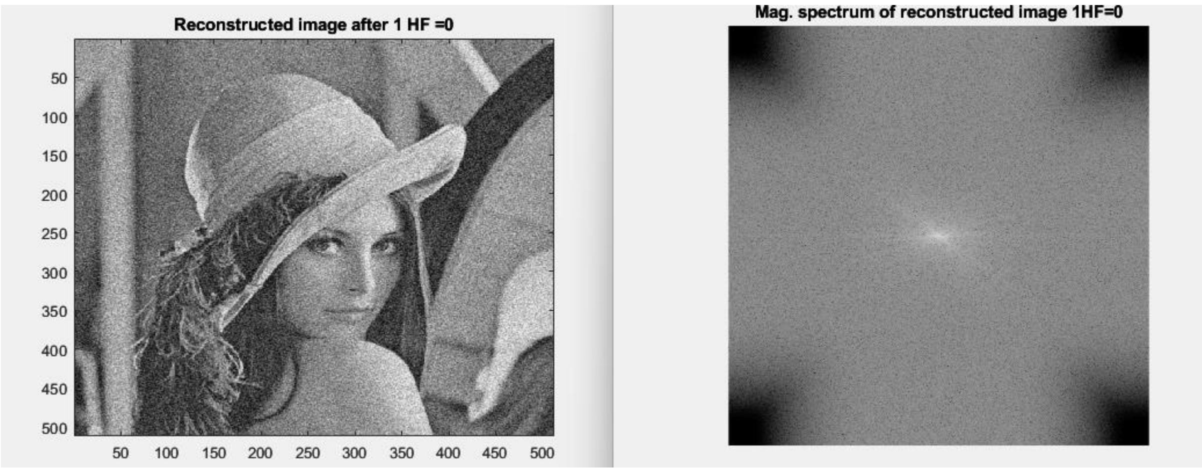
The Decompostion is carried out by applying the swt filter in the matlab with the level set to 5, the decomposition can be visualised by the following figure.



Thus we do that in the code and get a 16 band dyadic decomposition. Then we zero out the frequencies as directed.

16 band dyadic Case 1. Highest Frequency band is zeroed out.

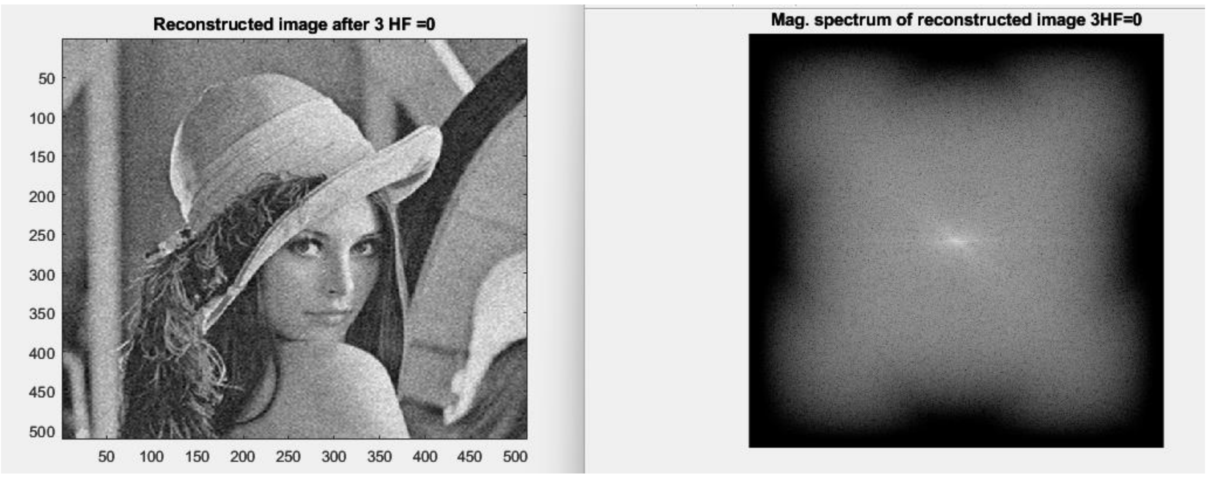
When the above is done, it is observed that the 2D DFT plot of the original image was modified. We see some black regions on the corner of the image which indicate that the highest frequency that were there originally, got removed, and when we look at the image it looks slightly better than our given original image.



16 band Dyadic Case 1

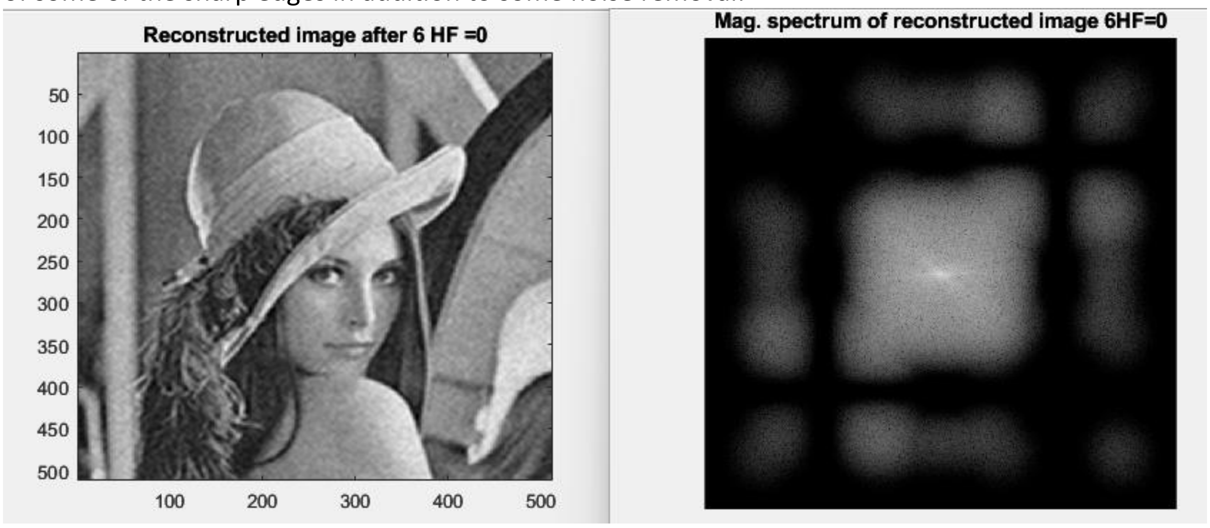
16 band dyadic Case 2: 3 highest frequencies are zeroed out.

Here the quality of the image further increases, indicating more noise reduction. When the 2DDFT is observed, we see that the there are more blacked out frequencies than in the previous case, indicating that more high frequencies were zeroed out.



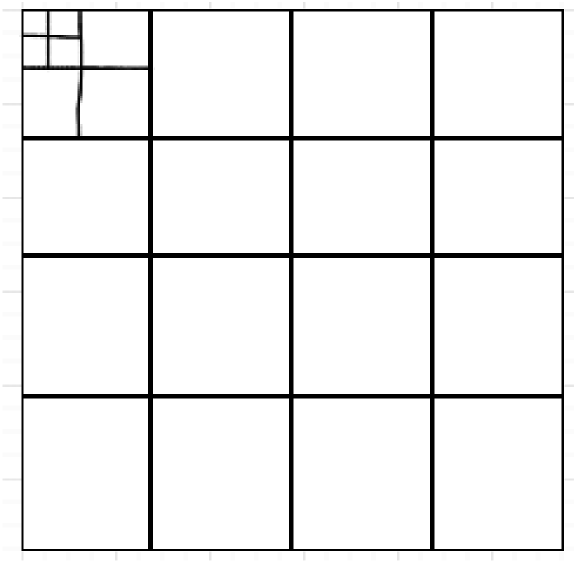
16 band Dyadic Case 2

16 Band dyadic case 3: 6 Highest Frequencies are zeroed out.
When the reconstructed image and its corresponding 2D DFT plot are observed, we see that most of the highest frequencies are zeroed out, and only very small number of low frequencies remain, doing this decreases the noise by a considerable amount, but also smooths the image, indicating removal of some of the sharp edges in addition to some noise removal.

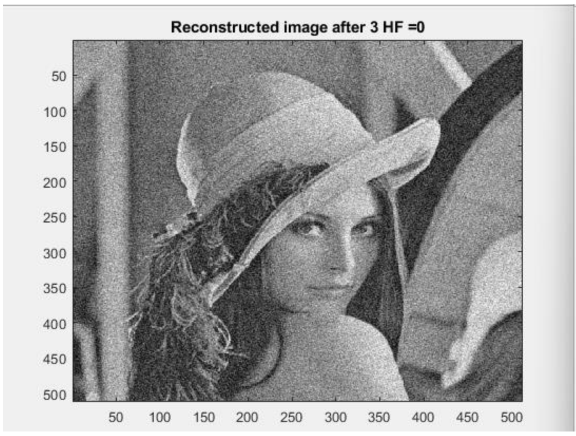


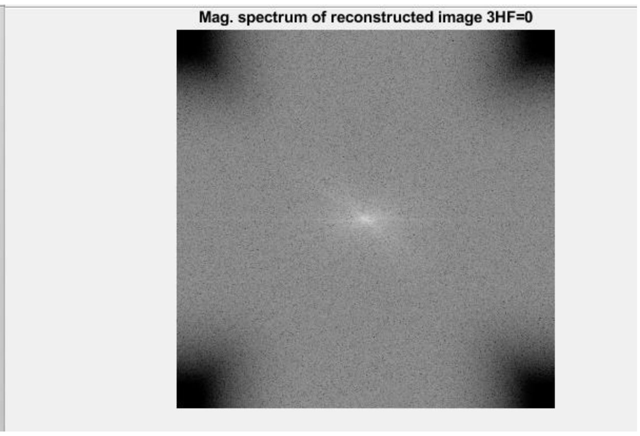
16 band Dyadic Case 3

22 Band modified Pyramid Decomposition: Here we decompose the image into 16 band and then further divide the lowest frequencies to 2 more level to achieve this, something similar to shown below.



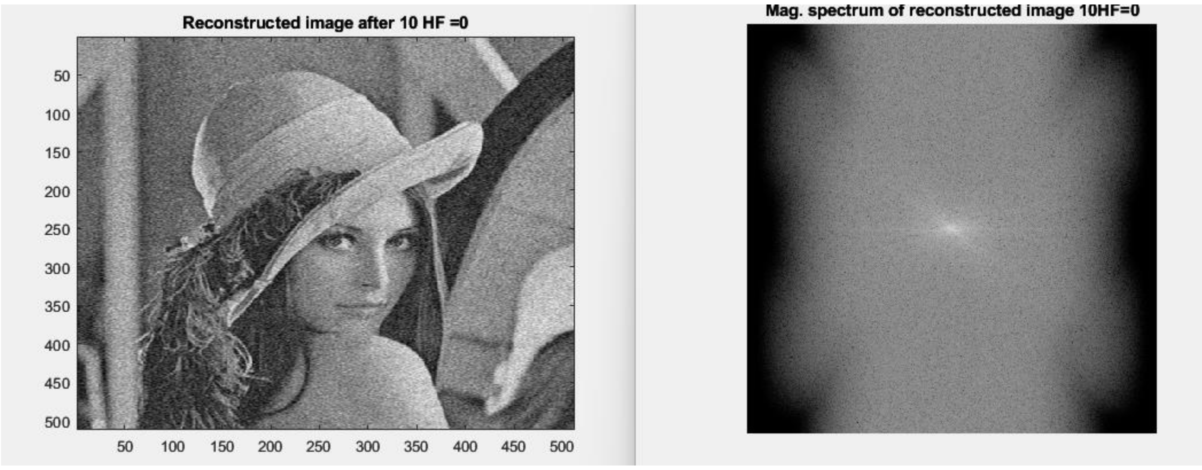
Case 1 : 3 Highest Frequency bands are zeroed out:
The results are somewhat similar to the case we saw in case 1 of dyadic case, with the 2D DFT looking as if some frequencies were removed as it gets blacked out, and the image that is reconstructed looks a bit less noisy





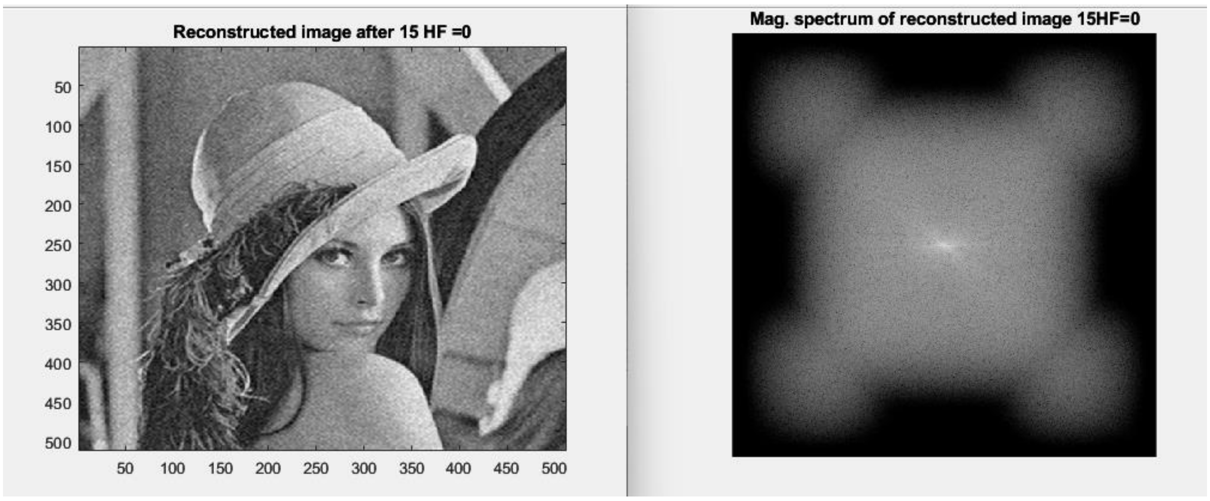
22 Band Case 1

Case 2: 10 Highest Frequency bands are zeroed out.
In this case some more frequency bands are made zero, this further improves the quality of the image(makes the image less grainy). We observe that the 2D DFT plot is has more frequencies blacked out.



22 Band Case 2

Case 3: 15 Highest Frequency are zeroed out: Most of the noise is filtered out in this case and this increase the quality of the image to a really better version(very less noise than the orginal).



22 Band Case 3