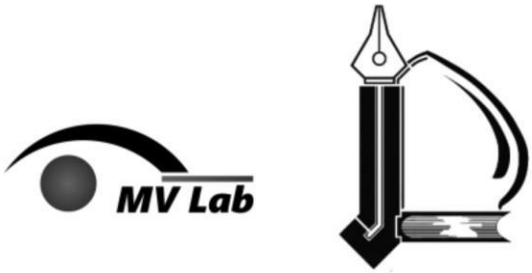


# EXERCISES

| | |
|---|---|
| Instructions | Appendix: Code with comments. |
| Delivery | • All homework should be sent through VU (No Telegram, Email, etc.).<br>• The report should be in PDF format named “Number of Homework-First Name Last Name.pdf”.<br>• Notice the deadlines. |
| Points | • Don't use MATLAB, Python, etc. library/toolbox for solving problems (Except math functions)<br>• Utilize functions when explicitly mentioned in the question.<br>• Any form of plagiarism will not be entertained and will result in a loss of grade.<br>• You can compare your own result by MATLAB, etc. output (optional). |

# 1. Frequency Domain

## 1.1. Fourier Transform

1.1.1. For each filter given below, compute its Fourier transform, and illustrate its magnitude and phase response. For each filter, if it is separable, compute the FT separately. If not, compute the FT directly. (Test on grayscale Lena Image)

$$a)\begin{bmatrix}-1 & -1 & -1\\ -1 & 9 & -1\\ -1 & -1 & -1\end{bmatrix}, b)\ \frac{1}{25}\begin{bmatrix}1 & 3 & 1\\ 3 & 9 & 3\\ 1 & 3 & 1\end{bmatrix}, c)\begin{bmatrix}0 & 1 & 0\\ 1 & -4 & 1\\ 0 & 1 & 0\end{bmatrix}, d)\begin{bmatrix}-1 & -2 & -1\\ 0 & 0 & 0\\ 1 & 2 & 1\end{bmatrix}$$

1.1.2. Perform 2D DFT on grayscale Lena, Barbara, and Baboon images. Display the magnitude of the DFT image with and without shifting and with and without logarithmic. Display and discuss the results.

## 1.2. Filtering

1.2.1. Write a program that filters grayscale Barbara image by zeroing out certain DFT coefficients and also display and compare the original and processed images.

a) Let $F(k, l) = 0$ for $TN < \{k, l\} < (1 - T)N$
($T$ = 1/2, 1/4, 1/8)

b) Let $F(k, l) = 0$ for the following regions :

i. $0 \le \{k \text{ and } l\} \le TN$;
ii. $0 <= k <= TN, \text{ and } (1 - T)N \le l \le N - 1$;
iii. $(1 - T)N \le k \le N - 1 \text{ and } 0 \le \{l\} \le TN$;
iv. $(1 - T)N \le k \text{ and } l \le N - 1$;

($T$ = 1/2, 1/4, 1/8)

Note: you can use fft2, ifft2, fftshift, and rgb2gray functions for problem 1.

# 2. Wavelet

## 2.1. Pyramid

2.1.1. For the Barbara image, build a 5 level Gaussian and Laplacian pyramid and display them in the pyramid format.

2.1.2. For the grayscale Lena image, manually compute a 3-level approximation pyramid and corresponding prediction residual pyramid. Use 3x3 averaging for the approximation and use pixel replication for the interpolation filters.

2.1.3. For the grayscale Lena Image, compute the wavelet transform (with 5-level) using the Haar analysis filters.

2.1.4. Quantize all the wavelet coefficients (whole sub-bands) created in Prob. 2.1.3 by a step size of $\gamma$ = 2. Then reconstruct the image from the quantized wavelet coefficients using Haar synthesis filter and Report PSNR values.

$$c'(u, v) = \gamma \times sgn[c(u, v)] \times floor\ [\ |c(u, v)|\ \gamma\ ]$$

($c$ represents the wavelet coefficient)

Note: you can use dwt2, idwt2, and psnr functions for problems 2.