Image Processing Spring 2024
Instructor: Prof. Zeyun Yu

Project 3: 2D DFT in Image Filtering

Assigned: March 5, 2024 (Tuesday)
Due 11:59pm: March 24, 2024 (Sunday)

In this project, you are asked to implement the discrete Fourier transform F(u, v) of an input image f(x, y) of size M*N and then apply the ideal low pass filter H(u, v) to smoothing the image by using the following equation:

$$g(x,y) = \mathfrak{I}^{-1}\{H(u,v)F(u,v)\},$$

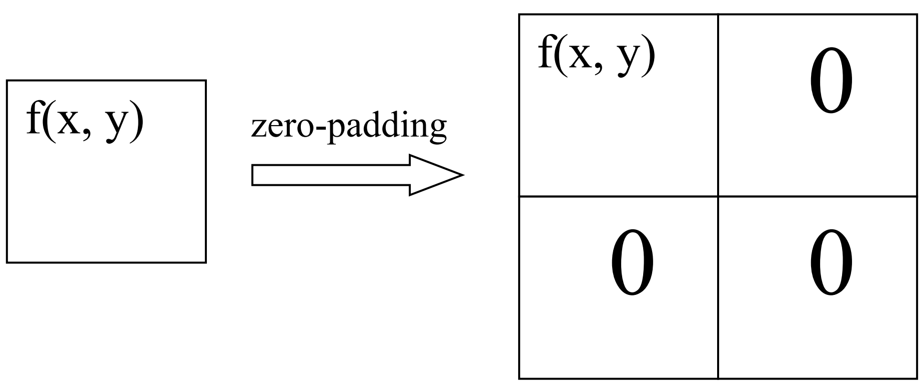
where g(x, y) is the output image (the smoothed image of f(x, y)) and the ideal low pass filter is defined as follows:

$$H(u,v) = \begin{cases} 1 & if \quad D(u,v) \le D_0 \\ 0 & if \quad D(u,v) > D_0 \end{cases},$$

where $D(u,v) = \left[(u-P/2)^2 + (v-Q/2)^2\right]^{\frac{1}{2}}$ (see below for the definitions of P and Q) and D_0 is called ***cutoff frequency***.

Notes:

(1) You need to zero-pad your original image to generate a new image of size P*Q, where P=2M-1 and Q=2N-1.



(2) You need to multiply your original image by $(-1)^{(x+y)}$ so that the low frequency of F(u, v) is centered at the center of your domain.

(3) You are required to use the fast 2D DFT algorithm to implement this project.
(4) Please use the image provided as your input.
(5) Two output images corresponding to two significantly different cutoff frequencies should be submitted.
(6) Please also submit the source code with your output images.
(7) You must implement the DFT by following the efficient DFT algorithm in $O(N^3)$ time complexity - calling any built-in functions provided by a 3rd party library is NOT allowed.