EECS 203A: HOMEWORK #4

Due: May 6, 2021

1. Consider a transform from an $M \times N$ input digital image $f(x, y)$ to an $M \times N$ output digital image $g(x, y)$ defined by

$$g(x, y) = 0.25\,[f(x, y+1) + f(x+1, y) + f(x-1, y) + f(x, y-1)]$$

a) Let $F(u, v)$ denote the DFT of $f(x, y)$. The DFT of $f(x - x_0, y - y_0)$ is given by

$$F(u, v)e^{-j2\pi(ux_0/M \; + \; vy_0/N)}$$

Use this relationship to find $G(u, v)$ as a function of $F(u, v)$.

b) Find the transfer function $H(u, v) = G(u, v)/F(u, v)$ for the transform.

c) Find the magnitude response $|H(u, v)|$ for the transform.

d) Generate a surface plot of $|H(u, v)|$.

e) Is this transform best described as lowpass or highpass or neither? Explain your answer.

2. Consider the Laplacian filter with -4 at the center of the mask.

a) Find the frequency response $H(u, v)$ of the filter.

b) Generate a surface plot of the magnitude response $|H(u, v)|$ of the filter.

c) Is this filter best described as lowpass or highpass or neither? Explain your answer.

Computer Problems:

a) Apply the 3×3 Laplacian filter with -8 in the center to the triangle image and the cat image. You can ignore the border regions where the convolution sum cannot be computed so that the output image will be smaller than the input image. Add a constant to the image so that the smallest negative value becomes zero and then scale into the range 0-255. Also apply the sharpening filter defined as the input image minus the Laplacian to the cat and triangle images. Submit your code and the four displayable filtered images.

b) Generate an image of the DFT magnitude $|F(u, v)|$ with the DC in the center for the cat and triangle images. Submit your code and the two displayable images.