UNIVERSITY OF PITTSBURGH

Department of Electrical and Computer Engineering

ECE 1390 Introduction to Image Processing

Computer Project 2 (Fall 2017)

Assigned: Oct 26
Due: Nov 15
References: Sections 3.1-3.7 and 4.7-4.10 (Gonzalez and Woods 3rd edition)

Problem 2.1 : Low pass filtering in spatial domain

a) Write a function w=gaussKernel(m,sigma) that uses the equation $G(x,y) = Ke^{-\frac{x^2+y^2}{2\sigma^2}}$ to generate a Gaussian lowpass filter of size $m \times m$.
b) Read the image testpattern.tif and lowpass filter it using a Gaussian kernel large enough to blur the image so that the large letter "a" is readable and the other letters are not. Display your final result.

Problem 2.2: Image sharpening in spatial domain

a) Read the image blurrymoon.tif and sharpen it using unsharp masking. Use a Gaussian lowpass kernel of your choice for the blurring step. Display your final result.
b) Improve the sharpness of your result using highboost filtering. Display your final result.
c) Sharpen the blurrymoon.tif image using the Laplacian kernel in Figure 3.37 (c). Display your final result. Compare your result of part c to the result of part b.

Problem 2.3: Lowpass filter transfer functions in frequency domain

a) Write a function H=lpfilterTF(type,P,Q,param) to generate a $P \times Q$ lowpass filter transfer function, H, with the following properties. If type='ideal', param should be a scalar equal to the cutoff frequency D_0 in equation 4.8-1. If type='gaussian', param should be a scalar value equal to the standard deviation D_0 in equation 4.8-7. If type='butterworth', param should be a 1×2 array (vector) containing the cutoff frequency and filter order $[D_0, n]$ in equation 4.8-5.
b) Generate a lowpass ideal filter transfer function of size 512×512 with $D_0 = 96$. Display your result as an image.
c) Generate a lowpass Gaussian filter transfer function of size 512×512 with $D_0 = 96$. Display your result as an image.
d) Generate a lowpass Butterworth filter transfer function of size 512×512 with $D_0 = 96$ and $n = 2$. Display your result as an image.

Problem 2.4 Highpass filter transfer functions in frequency domain.

a) Write a function H=hpfilterTF(type,P,Q,param) to generate a $P \times Q$ highpass filter transfer function, H, with the following properties. If type='ideal', param should be a scalar equal to the cutoff frequency D_0 in equation 4.9-2. If type='gaussian', param should be a scalar value equal to the standard deviation D_0 in equation 4.9-4. If type='butterworth', param should be a 1×2 array (vector) containing the cutoff frequency and filter order $[D_0, n]$ in equation 4.9-3.

b) Generate a highpass ideal filter transfer function of size 512×512 with $D_0 = 96$. Display your result as an image.
c) Generate a highpass Gaussian filter transfer function of size 512×512 with $D_0 = 96$. Display your result as an image.
d) Generate a highpass Butterworth filter transfer function of size 512×512 with $D_0 = 96$ and $n = 2$. Display your result as an image.

Problem 2.5 Filtering in frequency domain

a) Write a function g=fdfiltering(f,H) to filter image f with a given transfer function H. Your function should implement the seven steps described in Section 4.7.3.
b) To test your function,
   i. Read the images testpattern.tif and blurrymoon.tif
   ii. Use the function lpfilterTF from Problem 2.3 to generate the transfer function for a Butterworth lowpass filter with cutoff frequency 32 and order 2. Filter these two images and display your results.
   iii. Use the function hpfilterTF from Problem 2.4 to generate the transfer function for a Butterworth highpass filter with cutoff frequency 16 and order 2. Filter these two images and display your results.