Lecture 6 Project

1. Larger “Laplacian” Masks

It is shown that the Laplacian mask w8 = [1 1 1 ; 1 -8 1 ; 1 1 1] yields a result sharper than the result with a similar mask with a -4 in the center.

(a) Write an M-function that generates a ”Laplacian” mask of arbitrary odd size. For example, the mask of size 5 x 5 would consist of all 1s with a -24 in the center location.

(b) Download the image FigP0305(a)(blurry_moon).tif and compare the results between the results obtained with the Laplacian maks w8 and the results obtained with masks of size n x n for n = 5, 9, 15, and 25.

(c) Explain the differences in the resulting images.

2. Unsharp masking in the spatial domain

Unsharp masking consists of the following steps: (1) blur the original image; (2) subtract the blurred image from the original (the resulting difference image is called the "mask"); and (3) add the mask (or a fraction of the mask) to the original. In other words:

$$g(x,y) = f(x,y) - f_{\text{blurred}}(x,y)$$

This is the mask. Then,

$$f_{\text{unsharp}} = f + g(x,y)$$

It is not difficult to show that

$$f_{\text{blurred}}(x,y) = f(x,y) - f_{\text{sharp}}(x,y)$$

so that

$$f_{\text{unsharp}}(x,y) = f(x,y) + f_{\text{sharp}}(x,y)$$

If we use the Laplacian to produce the sharp image, then we can implement the preceding equation by convolving f with a 3 × 3 mask with a 1 in the center and 0s elsewhere; convolve f with a Laplacian mask; and add the results if the center coefficient of the Laplacian mask is positive, or subtract the results if we use a Laplacian mask whose center is negative. In either case, we can combine both operations by convolving f with the single mask:

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

Function fspecial generates the preceding unsharp spatial filter when you choose ALPHA = 0.

A slight generalization of the unsharp expression is as follows:

$$f_{\text{unsharp}}(x,y) = f(x,y) + k * f_{\text{sharp}}(x,y)$$

where k is a scaling factor.

(a) Use function fspecial to generate the unsharp spatial filter discussed above.

(b) Apply your unsharp filter to image FigP0305(blurry_moon).tif to sharpen the image.

3. An image is filtered four times using a Gaussian kernel of size 3x3 with a standard deviation of 1.0. Due to the associative property of convolution, equivalent results can be obtained using a single Gaussian kernel formed by convolving the individual kernels.

(a) What is the size of the single Gaussian kernel?

(b) What is its estimated standard deviation?

(c) Create and plot the single Gaussian kernel that gives equivalent results using the result of (a) and (b). Also, create and plot the equivalent kernel by applying the filter four times.

(d) Filter the image, 'testpattern512.tif', four times using a Gaussian kernel of size 3x3 with a standard deviation of 1.0. Filter the same image with the single Gaussian kernel created in (c). Compare and discuss the result.

(e) Repeat (a)-(b) using a Gaussian kernel of size 6x6 with a standard deviation of 1.0. Discuss the results.