Lab 1:

Collect at least six grayscale images that contain most of the following features:

- a collection of small objects
- a collection of large objects
- strongly oriented or directional features
- fine texture
- coarse texture
- geometrical shapes with sharp edges
- human faces
- smooth features
- sharp edges
- periodic patterns

You may select a few photos from your own photo album. Limit synthesized images to one or two in the collection. Limit images borrowed from web sites to one or two in the collection. A given image may contain more than one of the features listed above.

If you collect color images, convert them to grayscale images. To minimize processing time, resample and resize your test images to the order of about 1k × 1k pixels each.

For the purposes of lab exercises, note that MATLAB can read images in tiff, gif, jpeg, bmp, ras, ppm, pgm, and a few other file formats. For more details, enter MATLAB (including the Image Processing Toolbox) and type in "help imread".

Lab 2:

Obtain the histograms and log-magnitude Fourier spectra of at least six test images from your collection of test images.

You may use the following MATLAB Image Processing Toolbox commands: imread, imshow, imadjust, imhist, fftshift, fft2. Use the "help" facility in MATLAB for details.

Use "print -deps filename.eps" to save the current figure as a .eps file for printing.

Write notes on the nature of the histograms and the Fourier (log-magnitude) spectra of your test images.

Relate specific features in the images to specific components or properties of the histograms and spectra.

Write notes on the usefulness of the histograms and spectra in understanding the information content of images.

Lab 3:

Select one of your images as the test image for this exercise.

Using the MATLAB function "conv2" with the option to maintain the same image size, prepare two blurred versions of the test image by applying the 5×5 mean filter

(i) once,

(ii) twice.

Using the MATLAB function "imnoise", add

(a) Gaussian noise,

(b) salt-and-pepper noise,

(c) speckle noise

separately to each of the two blurred images obtained as above as well as the original image.

Select the noise level such that some of the fine details in your test image are obscured.

Study the effect of blurring and noise on the test images, their histograms, and their Fourier spectra.

Describe and explain your findings.

Lab 4:

From your collection of test images, select two images:

one with strong edges of the objects or features present in the image,

and the other with weaker definition of edges and features.

Compute the horizontal difference, vertical difference, and the Laplacian of the images (Equations 2.76 and 2.82).

Find the minimum and maximum values in each result, and map appropriate ranges to the display range in order to visualize the details present in the results.

Study the results obtained and comment upon your findings in relation to the details present in the test images.

MATLAB commands: min(min(x)), max(max(x)), conv2, imshow(x, [x1 x2]), imadjust(x, [x1 x2], [y1 y2], gamma)

Lab 5:

From your collection of test images, select two images:

one with strong edges of the objects or features present in the image,

and the other with weak edges and features.

Prepare noisy versions of the images by adding

(i) Gaussian noise, and

(ii) salt-and-pepper noise.

Filter the noisy images using

(i) the median filter with the neighborhoods given in Figure 3.14 (e), (f), and (k).

(ii) the mean filter with the neighborhoods given in Figure 3.14 (e), (f), and (k).

Compare the results with the original image in terms of noise removal, NMSE (Equation 2.98), LMSE (Equation 2.100), and the qualitative effects of the filters on the edges present in the images.

MATLAB commands: imnoise, nlfilter, conv2, medfilt2, median

Lab 6:

Select two of the noisy images from lab5.

Apply the ideal lowpass filter and the Butterworth lowpass filter using two different cutoff frequencies for each filter (in the 2D frequency domain).

Display the frequency response (magnitude) of your filters and verify their characteristics.

Display the log-magnitude Fourier spectra of your images before and after filtering and verify the results.

Discuss the results in terms of noise removal as observed visually and NMSE (Equation 2.98).

Discuss the effect of the filters on the sharpness of the edges present in the images.

Discuss any undesirable effects or artifacts caused by the filters.

MATLAB commands: fft2, fftshift

Lab 7:

Select two images from your collection, with one containing relatively sharp and well-defined edges, and the other containing smooth features.

Apply the unsharp masking filter, the Laplacian operator, and the subtracting Laplacian filter to the images. Study and discuss the results in terms of edge enhancement or edge extraction.

Create noisy versions of the images by adding Gaussian noise.

Apply the methods as above to the noisy images.

Study and discuss the results in terms of the effect of noise on edge enhancement or edge extraction.

Comment on the undesirable effects or artifacts introduced by the operators.

Lab 8:

Select two images from your collection, with one containing relatively sharp and well-defined edges, and the other containing smooth features.

Apply the ideal highpass filter, the Butterworth highpass filter, and the Butterworth high-emphasis filter to the images. Use at least two different cutoff frequencies.

Display the frequency response (magnitude) of your filters and verify their characteristics.

Display the log-magnitude Fourier spectra of your images before and after filtering and verify the results.

Study and discuss the results in terms of edge enhancement or edge extraction.

Create noisy versions of the images by adding Gaussian noise.

Apply the filters as above to the noisy images.

Study and discuss the results in terms of edge enhancement or extraction and the effect of noise on edge enhancement or edge extraction.

Use appropriate ranges of the results for display and visualization with imshow(x, [x1 x2]).

Lab 9:

Select two images from your collection containing objects with gray levels that are well separated from the gray levels of the background.

Use the MATLAB functions im2bw and graythresh to binarize each image and detect the objects present in the image (see Section 5.1 of the textbook).

Apply a suitable derivative operator and obtain the contours of the objects from the binarized results. Evaluate the quality of the contours and artifacts in the results.

Study the results and comment upon the performance of the methods.

Use appropriate ranges of the results for display and visualization with imshow(x, [x1 x2]).

Suggest further operations to improve your results.

Lab 10:

From your collection of test images, select two images: one with strong edges of the objects or features present in the image, and the other with weaker definition of edges and features.

Compute the results of application of the 3×3 Prewitt operators for 0, 45, 90, and 135 degrees (see pp 368 - 369 of the textbook).

Compute also the magnitude of the gradient as defined in Equation 5.9.

Filter the test images with Gaussian functions and obtain the Laplacian of Gaussian at three different scales.

Find the minimum and maximum values in each result, and map appropriate ranges to the display range in order to visualize the details present in the results.

Study the results obtained and comment upon your findings in relation to the details present in the test images.

Compare the results with those obtained in Lab 4.

MATLAB commands: min(min(x)), max(max(x)), conv2, imshow(x, [x1 x2]).