

# CS474/674 Image Processing and Interpretation

Fall 2009 – Dr. George Bebis

## Programming Assignment 4

**Due Date: 11/17/2009**

In this assignment, you will implement the homomorphic filtering technique. Many times, images suffer from shading problems due to uneven illumination. The role of homomorphic filtering is to alleviate such problems. In your experiments, use the image shown below (i.e., can be downloaded from the course's webpage). As discussed in class, the main idea behind homomorphic filtering is to separate the illumination and reflectance components by applying the logarithmic function on the image. Then, you would need to apply an appropriate high-pass filter, which will emphasize high frequencies and attenuate lower ones, preserving fine detail at the same time.



Here are the main steps:

1. Apply the **ln** function (natural logarithm) on the image.
2. Take the Fourier Transform of the image from step 1.
3. Apply high-pass filtering
4. Take the Inverse Fourier Transform of the image from step 3.
5. Apply the **exp** function (exponential function) on the image from step 4.
6. Display the magnitude of the image from step 5.

Note that in certain cases, the gray levels will be bigger than 255; applying a regular normalization and displaying the image will not give good results and it is better if you use a **log** function as we did with the spectrum of the Fourier Transform.

The high-pass filter that you would be using in your experiments is a Butterworth filter, characterized by the following transfer function:

$$H(u, v) = \gamma_L + \frac{\gamma_H}{1 + [D_0/D]^2}$$

where  $D = \sqrt{(u - N/2)^2 + (v - N/2)^2}$ ,  $D_0$  is the cutoff frequency of the filter and  $\gamma_L$   $\gamma_H$  are the gains for the low and high frequencies correspondingly. Note that before you apply the filter on the image, you must first center it as in the case of the Fourier Transform spectrum. A summary of steps for filtering in the frequency domain is given on page 263 in your textbook.

### **Choosing the parameters of the filter**

You are going to experiment with different parameter values. As a starting point, choose  $D_0=1.8$ ,  $\gamma_L=0.5$  and  $\gamma_H=1.5$ . Then, keep the cutoff frequency the same and increase/decrease  $\gamma_L$  and  $\gamma_H$ . For example, assume combinations of  $\gamma_L$  and  $\gamma_H$ , with  $\gamma_L$  taking values from [0.2-0.8] and  $\gamma_H$  taking values from [1.2-1.8]. Print and comment your results. Which set of parameters has yielded the best results? Do you see any consistency in your results as you decrease or increase  $\gamma_L$ ? What about as you decrease or increase  $\gamma_H$ ?

**Graduate Students Only:** A popular procedure for image enhancement combines high-frequency emphasis and histogram equalization to achieve edge sharpening and contrast enhancement (see Fig 4.59, page 290). (a) Does it matter which process is applied first? (b) if the order does matter, give a rationale for using one of the other method first. Justify your answers either experimentally or theoretically.

**Laboratory Write-up:** You are to turn in a brief report which should include the following: a description of the experiments, theoretical background (what the reader needs to know to understand the experiments), methodology (explanation of the methods used), results (include graphic output of all of your results), explanation of results (justify your results and answer the questions that might exist in the handout), and a brief summary of what you have learned. **The report is very important in determining your grade for the programming assignment.** Be well organized, type your reports, and include figure captions with a brief description for all the figures included in your report. Motivation and initiative are greatly encouraged and will earn extra points.