

CS/ECE 545 Digital Image Processing
Homework 2, Spring 2014 (Due March 5, by 6PM)

Note: Some of the problems below include questions for you to answer. Put your answers in a separate Word or PDF document and submit it in a zip file that also your code.

- 1. Burger & Burge Exercise 5.7 (page 85) (25 points):** Using a histogram specification for adjusting *multiple* images (Section 5.6.4 of text), one could either use one typical image as the reference or compute an average reference histogram from a set of images. Implement the second approach in a plugin called `histogram_spec_averages.java` and test it on ImageJ samples. Discuss its possible advantages (or disadvantages). Be sure to indicate in your documentation which sets of images you tested your implementation on.
- 2. Laplacian Filter (19 points):** Write an ImageJ plugin `Laplacian_Filter_with_c.java` to sharpen an image by computing the Laplacian of the image and adding some amount c of that back to the original image. The resulting mask should be

	$c/4$	
$c/4$	$1-c$	$c/4$
	$c/4$	

Your plugin should work on 8-bit grayscale images and accept positive and negative values of c . Test your program on some sample images from ImageJ and answer the following questions. Indicate in your documentation, which of the ImageJ samples you tested your program on.

- a. (2 points)** What value(s) of c give the best-looking results?
 - b. (2 points)** What happens to the image when the parameter is too high or too low?
- 3. Restoration of degraded images (24 points):** The following 2 images (Degraded_A & Degraded_D) have been degraded in some way. Try to observe what type of degradation has been done on the images and restore them. The undegraded original is also shown (c). Write plugins `restore_img_a.java` and `restore_img_d.java` that restore images a and d. In your readme file, explain what you did to restore the images. Don't forget to cite any equations, references or parameters you use.



Degraded Images (a & b)



Desired (restored) image (c)

4. **Spatial Filtering (32 points):** In this assignment you will create a filter that will either blur or sharpen an image depending on the value of a user-specified variable. Declare this control variable in your program so that it can be modified before running your plugin. Since the functions you will implement have several variables, you should also declare appropriate variables in your code.
- (12 points) Create a plugin called **Gaussian_Blur** that implements a separable Gaussian filter. This class should have a settable member variable `sigma` and a kernel radius equal to three times `sigma`. Handle boundary pixels by the “extend” method. **Hint:** You may use the `makeGaussKernel1D` function from the book, but be sure to normalize your kernel!
 - (12 points) Create a plugin called **Blur_Or_Sharp** that has a parameter `w` between -1 and 1 that performs the following:

$$I' = (1 + w) \cdot I - w \cdot I * G_{\sigma},$$

where $I * G_{\sigma}$ is the application of your `Gaussian.Blur` filter to I .

Turn in: `Gaussian_Blur.java`, `Blur_Or_Sharpen.java`

Answer the following questions

Run your `Blur_Or_Sharpen` filter on the example images given. Try out several values for parameters σ and w .

- i. **(2 points)** What value of w gives the most blurring? Explain why
- ii. **(2 points)** What value of w gives the most sharpening? Explain why
- iii. **(2 points)** Run your filter on any image with the maximal amount of blurring (i.e. the w value from question 1 and with $\sigma = 10$). Now try to reverse this by sharpening the image with the maximal amount of sharpening (the w from question 2) and the same $\sigma = 10$. Did you recover the original image? Why or why not?
- iv. **(2 points)** Run your filter on the image `pattern.tif` with $w = 1$ and $\sigma = 10$. Describe the artifacts you see in the filtered image. Why does this happen?

Submitting Your Work

Submit all ImageJ plugins (`histogram_spec_averages.java`, `Laplacian_Filter_with_c.java`, `restore_img_a.java`, `restore_img_d.java`, `Gaussian_Blur.java`, `Blur_Or_Sharpen.java`) and your README file in Word or PDF put into ONE zip file named *yourfirstname_yourlastname_hw2.zip* using `turnin`. Your README should contain all your answers to the questions above.

DON'T EMAIL ME YOUR HOMEWORK. Also, TEST YOUR CODE IN THE ZOOLAB BEFORE SUBMITTING