ECE 178 HW #2
Due: Wednesday, Oct 15, 2008

Chapter 2
Problems 2.15, 2.16, 2.17,

Chapter 3
Problems 3.4, 3.5

Programming assignment
In this MATLAB assignment, we shall study the effect of histogram equalization and how it can be implemented with a piecewise linear transformation of the pixel values. The original image is lena.gif. Plot its histogram using the imhist command in MATLAB. Then, consider the darkened version of the image, called daklena.gif. Again, plot its histogram using the imhist function and comment on the histogram difference between the 2 images. For the 2 gif images, see class website www.ece.ucsb.edu/~manj/ece178.

Then, use the histogram equalization command in MATLAB, called histeq, on the darklena.gif image. Comment on the image quality obtained after the histogram equalization and comment on its histogram, with respect to the histograms obtained from lena.gif and darklena.gif.

Now, we shall study the effect of using an appropriate piecewise linear transformation to the pixel values. The logic is as follows: say, we provide 2 vectors a = [a_1; a_2; a_3; a_4] and b = [b_1; b_2; b_3; b_4] as input. Then, as showed in Fig. 1, the region [a_1 , a_2] is mapped to [b_1 , b_2], the region [a_2 , a_3] is mapped to [b_2 , b_3] and the region [a_3 , a_4] gets mapped to [b_3 , b_4]. You have to choose a proper set of values for a = [a_1; a_2; a_3; a_4] and b = [b_1; b_2; b_3; b_4] and then use them to perform piecewise linear transformation of the pixel values.

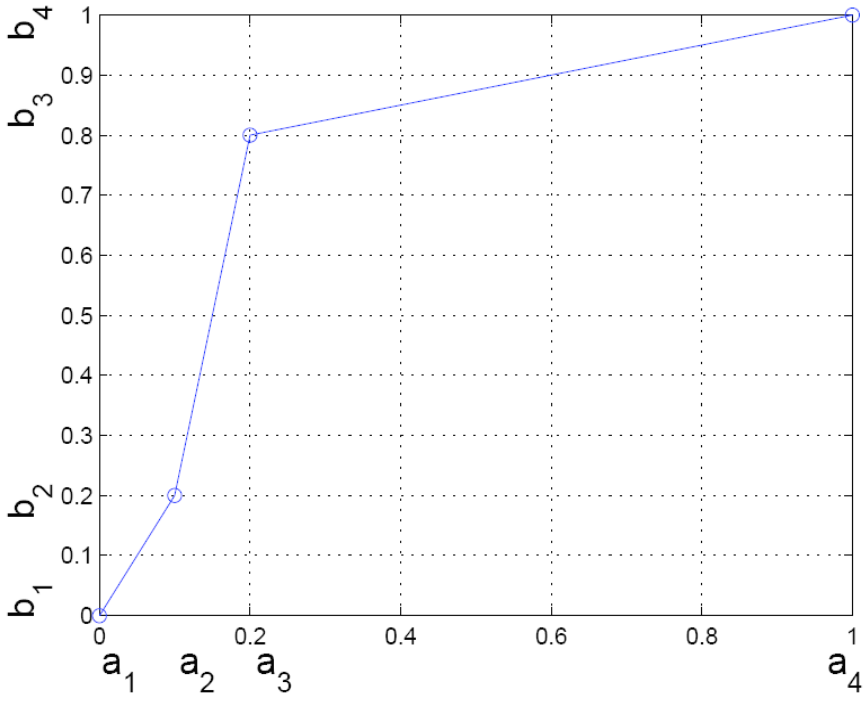

Figure 1: A piecewise linear stretching function using $\mathrm{a} = [a_1, a_2, a_3, a_4] = [0, 0.1, 0.2, 1.0]$ and $\mathrm{b} = [b_1, b_2, b_3, b_4] = [0, 0.2, 0.8, 1.0]$.

Your MATLAB routine should take the darklena.gif image and a and b as inputs, and the output should be the image, with piecewise linear transformation performed. Using Fig. 1 as the reference, you should use vectors a and b, each of length 4, and set $a_1 = 0$, $a_4=1$, $b_1 = 0$ and $b_4 = 1$. Then, you should intelligently choose a_2; a_3; b_2 and b_3, so that the perceptual quality of the image obtained after piecewise linear transformation is good.

The pseudocode is as follows:
• *im* = input image matrix
• use "find" function in MATLAB to find the pixel values in the image between a_i and a_{i+1}, for all *i*.
• The line between the coordinates (a_i; b_i) and (a_{i+1}; b_{i+1}) has the equation:

$$y = \frac{b_{i+1} - b_i}{a_{i+1} - a_i}(x - a_i) + b_i$$

To implement the above mentioned logic in MATLAB, use

$$pix = \text{find}(im >= a(i) \quad \& \quad im < a(i+1));$$
$$out(pix) = (im(pix) - a(i)) * (b(i+1) - b(i))/(a(i+1) - a(i)) + b(i)$$

where *im* is the input image and *out* is the output image.
• Repeat the above process for all *i* and thus, *im* will be converted to *out*.

Things to turn in:
(a) M-file
(b) Images obtained after using histeq and after using piecewise linear transformation
(c) Also plot their histograms along with the histograms of lena.gif and darklena.gif.
(d) Comments on the differences between the histograms and also justify how you chose a and b for the piecewise linear transformation problem.