ECE4445 / MBP4445 / ECE9201 / ECE9021 / BME9509 / MBP9509

INTRODUCTION TO DIGITAL IMAGE PROCESSING

PRACTICE PROBLEMS – POINT OPERATIONS

Unlike assignments, practice problem sets will not be collected and will not be marked, but they may be tested on quizzes and on the final examination.

1. Try `imcontrast` in MATLAB. Use it to perform a window and level operation.

2. Type the following commands at the MATLAB prompt:

```
>> im = [1 2 3; 4 5 6; 7 8 9];
>> f = [2 1 9 7 8 5 4 6 3];
>> im2 = f(im)
```

a) What does the statement `im2 = f(im)` do?

b) Design a row vector `f1` that applies a window of width W=38 and level L=74 to the uint8 intensity image `head.tif`. Ensure that the resulting output image is of type uint8. Plot the vector `f1`, the original image and the resulting image. **NOTE:** The image `head.tif` is available on the course Web site.

3. Write a MATLAB function called `match` that implements the histogram matching algorithm for 8-bit images that was described in class. The function header should have the form `function im2 = match(im, h)` where `im` is a uint8 intensity image, `h` is the 256-bin histogram to be matched and `im2` is the output image. You can use any built-in MATLAB functions in your code except for `histeq`.

   Histogram matching can be used to perform histogram equalization by appropriate specification of the desired histogram. Equalize the uint8 intensity image `pout.tif` using the function `match` and include a printout of the output in your report. Also include a plot of the vector `h` that you used as input. Try to place all plots and images on the same page using the `subplot` command.

4. Try the following two questions from Dr. Castleman's book:

- An 8-bit image has a histogram given by $H(D) = 1704 \sin(\pi D / 255)$. Find a point operation that will flatten the image. You can assume continuous variables. **[Question 5, Chapter 6 of Castleman's book.]**

- [We did this one in class, but make sure you can do it on your own.] Suppose you are given two X-ray films taken immediately before and after injection of a contrast medium (dye) into the arteries of a patient's heart. Radiologists are studying the films to determine whether coronary bypass surgery or heart valve replacement is required. Normally they use digital image subtraction to visualize the dye as it fills the arterial passageways. In this case, however, problems in exposure and development of the two films make a direct comparison inconclusive. The patient is too weak to undergo the angiography procedure again. Only digital subtraction (Chapter 7) of the two images will reveal the extent of coronary disease. To a good approximation, the histograms of the two images are given by the Rayleigh distribution $H(D) = \frac{DD_m}{\alpha^2}\exp\left(-\frac{D^2}{2\alpha^2}\right)$ where $D_m = 63$, $\alpha = 16$ for the first image, and $\alpha = 24$ for the second image. What GST would: (a) flatten the histogram of the preinjection image? (b) flatten the histogram of the postinjection image? (c) make the histogram of the postinjection image match that of the preinjection image? You can assume continuous variables. **[Question 8, Chapter 6 of Castleman's book.]**

5. Find a point operation (in tabular form) that will equalize a 3-bit image with the following histogram:

D_A	$H_A(D_A)$
0	1028
1	3544
2	5023
3	3201
4	1867
5	734
6	604
7	383

6. Given a 3-bit image with the following histogram,

D_A	$H_A(D_A)$
0	0
1	0
2	4096
3	4096
4	4096
5	4096
6	0
7	0

find a point operation (in tabular form) that will match it to the following histogram:

D_C	$H_C(D_C)$
0	0
1	1365
2	2731
3	4096
4	4096
5	2731
6	1365
7	0