E E 2 9 5 January 30, 2008

LAB 2 - Image Enhancement Techniques

Lab Report Due: February 8, 2008

Go to Course Materials in the Course Home Site. Under EE 295 Labs., go to Software and obtain the file IP01.zip. Store it and set your MATLAB working directory so that you have access to all these files. Programs in IP01 are needed for many of the problems in the Labs.

This Lab gives a brief introduction to some basic Image Enhancement techniques in MATLAB:

Adjusting image intensity

(1) Histogram stretching

(2) Histogram equalization

(3) Histogram adjustment

Enhancing images using arithmetic operations

(1) addition - to increase brightness

(2) multiplication - to increase sharpness

(3) subtraction - to detect change

(4) division - to detect change

Correctting image alignment
Cropping and resizing images

Do the following:

(1) Read Section 5 of your notes. Go through all the experiments in Section 5.

(2) Note that you have all the programs in your working directory. So, for instance on page 5-5, you only need to type 'stretch_pout' to invoke the program. Also, if you want to see program stretch_pout.m, just type 'edit stetch_pout' in the Command Window.

Lab Report:

(1) In the MATLAB Command Window, it is often useful to see the Workspace variables and their formats in the top left hand region. Explain what you have to do to obtain those variables and what other options are possible for that part of the Command Window.

(2) What does histogram stretching do? How are the histograms of the pre-streched and post-stretched images related (approximately)?

(3) On page 5-5 in Histogram stretching, what is the original format of the image I? Why is it necessary in the algorithm (stretch_pout.m) to convert the image to to double precision? What would happen if you did not do the conversion?

(4) The image J = imread('pout.tif') is of size = 291*240 = 69840 pixels. It has a certain histogram as seen by 'imhist(J)' where we see that most of the intensities lie between 75 and 150. On page 5-6, the desired hgram = [0 0.2 0.4 0.6 0.8 1.0]. Now, what are all the intensities and how many pixels have these intensities?

(5) On page 5-6, you do histogram equalization and increase contrast. Question: While the pixel values have been redistributed, is the basic image still preserved in terms of its shape, size, etc.? That is, were you to do edge detection on the histogram equalized image, would you still see the same person as before? Do edge detection on both images I and J2 as follows:
BW1=edge(I, 'canny'); BW2=edge(J2,'canny'). Imshow(BW1), Imshow(BW2).
Comment.

(6) What if you just wanted the edge map of the subject and not the background? How would you approach this problem?

Histogram Equalization

Histogram equalization is a technique which consists of adjusting the gray levels in an image such that the resulting intensity histogram of the transformed image is uniform. Let X represent a continuous random variable which indicates the gray level of the image. We can assume that the values of X lie in [0,1]. Consider the transformation of the random varaible X,

$$Y = g(X)$$

Let the transformation g satisfy the following:

- $g(X)$ is a single-valued function, monotonically increasing in the interval [0,1]
- $g(X)$ lies in [0,1]

The first condition preserves the order from black to white in the gray scale and the second that the function is consistent with the allowed range of pixel gray scale values.

The input random variable X is described by cdf and pdf as $F_X(x)$ and $f_X(x)$ respectively and the transformed random variable Y, by $F_Y(y)$ and $f_Y(y)$ respectively. It can be easily shown that $f_Y(y)$ is obtained as

$$f_Y(y) = f_X(x)|_{x=h(y)} \frac{dh(y)}{dy} = f_X(h(y))|\frac{dh(y)}{dy}|$$

That is, the transformed density function is equal to the input density function with the old variable replaced by the appropriate function of the new variable, times the derivative of the new function with respect to the transformed variable.

If the transformation is given by

$$Y = g(X) = \int_0^x f_X(\eta) d\eta$$

then substituting $\frac{dx}{dy} = \frac{1}{f_X(x)}$ in the previous equation gives us $f_Y(y) = 1$. Thus it is possible to obtain a uniformly distributed pdf Y.

Of course, an algorithm implements the discrete version of this. Images may be enhanced by “equalizing” the histogram, but note that the dynamic range of the enhanced image is typically extended.