EELE 5110 Digital Image Processing Lab.
Lab. 5
Image Enhancement in The Spatial Domain II

1. Objectives:

- Performing Image Enhancement using histogram equalization.
- Performing Image Enhancement using image subtraction.
- Performing Image Enhancement using averaging.

2. Theory:

I) Histogram equalization:

It is an enhancement technique for general purpose contrast manipulation. Histogram equalization transforms the gray levels of the input image and spreads them onto the available full range of gray levels so that the output image of high contrast. It has been proven that transforming the input image using a transformation function, which is related to the probability density function of the gray levels of the input image, would give an output image of uniformly distributed gray levels. For digital images, this yields:

$$S_k = T(r_k) = \sum_{j=0}^{k} \frac{nj}{n}$$

where n_j is the number of pixels in the j^{th} gray level in the input image and n is the total number of pixels in the image.

II) Image enhancement using subtraction:

In image subtraction, the difference between two images f(x,y) and h(x,y), expressed as:

$$g(x,y) = f(x,y) - h(x,y)$$

Image subtraction can be used for enhancement purposes. The idea is to enhance the difference between 2 or more images. It has a wide spectrum of applications, especially in the processing of medical images. This concept is to be illustrated here by discarding (setting to zero) the least significant of the original image, perform pixel-by-pixel difference between the original image and the image of the discarded bits, and then perform contrast stretching transformation (like histogram equalization) on the difference image.

III) Image Enhancement using averaging:

In some fields, such as astronomical applications, noisy images are likely to be produced due to low-illumination imaging sources and thermal noise produced by the sensors themselves. This can be corrected by observing the same scene for along time, capturing several images, and then averaging them.

Assume that:

$$g(x,y) = f(x,y) + \eta(x,y)$$

where: g(x,y) = noisy image
f(x,y) = original image
η(x,y) = noise image

then
$$g'(x,y) = \frac{1}{k}\sum_{i=1}^{k} gi(x,y)$$

3. Experimental work:

I) **Develop the Matlab codes that will perform the enhancements described above. (histogram equalization has to be applied for the images: Fig3_15_a_1.jpg, Fig3_15_a_2.jpg, Fig3_15_a_3.jpg, Fig3_15_a_4.jpg, pout.tif, saturn.tif, tire.tif)**

II) **Comment on the results for each code individually.**

4. Home Exercise:

III) **Write 2 functions that implement the histogram, histogram equalization functions built in the MATLAB.**