

Lecture 7

Fourth stage

Medical Physical Department



Medical Imaging Processing

Image Histogram

By

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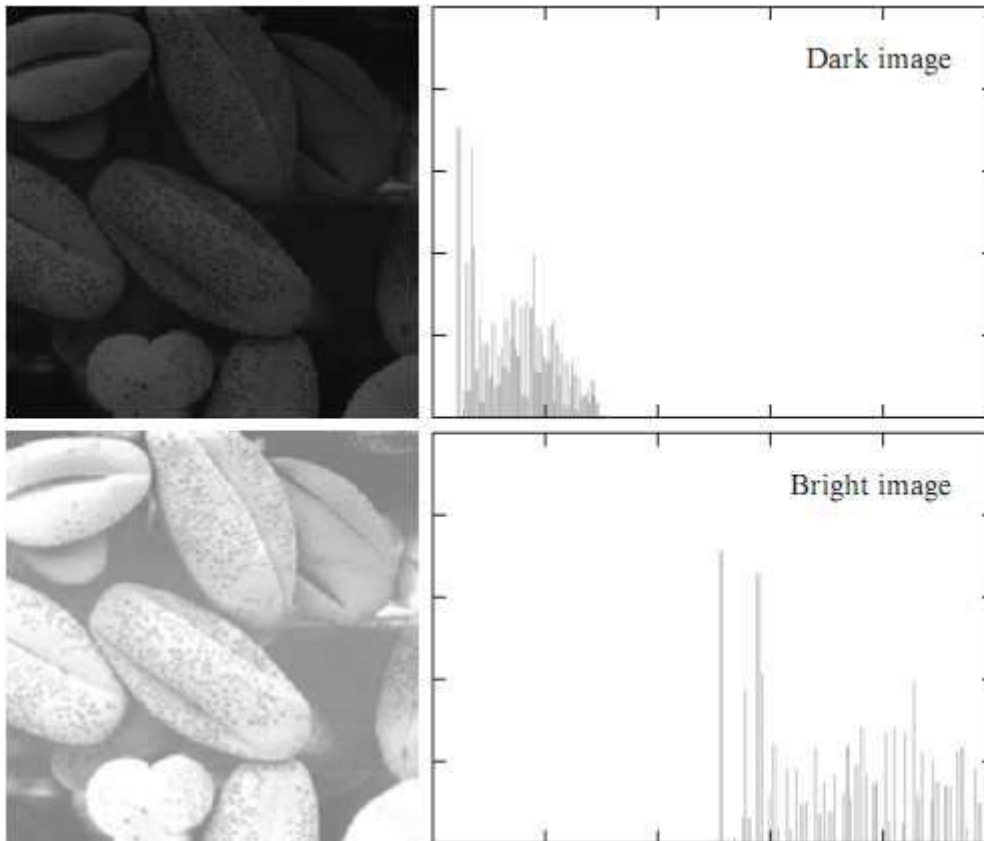
1. Image Histogram

The histogram of an image is a plot of the gray _levels values versus the number of pixels at that value. A histogram appears as a graph with "brightness" on the horizontal axis from 0 to 255 (for an 8-bit) intensity scale) and "number of pixels "on the vertical axis. The histogram gives us a convenient –easy -to -read representation of the concentration of pixels versus brightness of an image, using this graph we able to see immediately:

- 1- Whether an image is basically dark or light and high or low contrast.
- 2- Give us our first clue a bout what contrast enhancement would be appropriately applied to make the image more subjectively pleasing to an observer, or easier to interpret by succeeding image analysis operations.

So the shape of histogram provide us with information about nature of the image or sub image if we considering an object within the image. For example:

- Very narrow histogram implies a low-contrast image
- Histogram skewed toward the high end implies a bright image
- Histogram with two major peaks , called bimodal, implies an object that is in contrast with the background



Figure(1): histogram of image

Given a greyscale image, its histogram consists of the histogram of its grey levels; that is, a graph indicating the number of times each grey level occurs in the image.

- In a dark image, the grey levels (and hence the histogram) would be clustered at the lower end:
- In a uniformly bright image, the grey levels would be clustered at the upper end:
- In a well contrasted image, the grey levels would be well spread out over much of the range.

There are **two** ways to enhance its contrast, by spreading out its histogram:

Histogram Modifications

The gray level histogram of an image is the distribution of the gray level in an image. The histogram can be modified by mapping functions, which will stretch, shrink (compress), or slide the histogram. Figure (2) below illustrates a graphical representation of histogram stretch, shrink and slide.

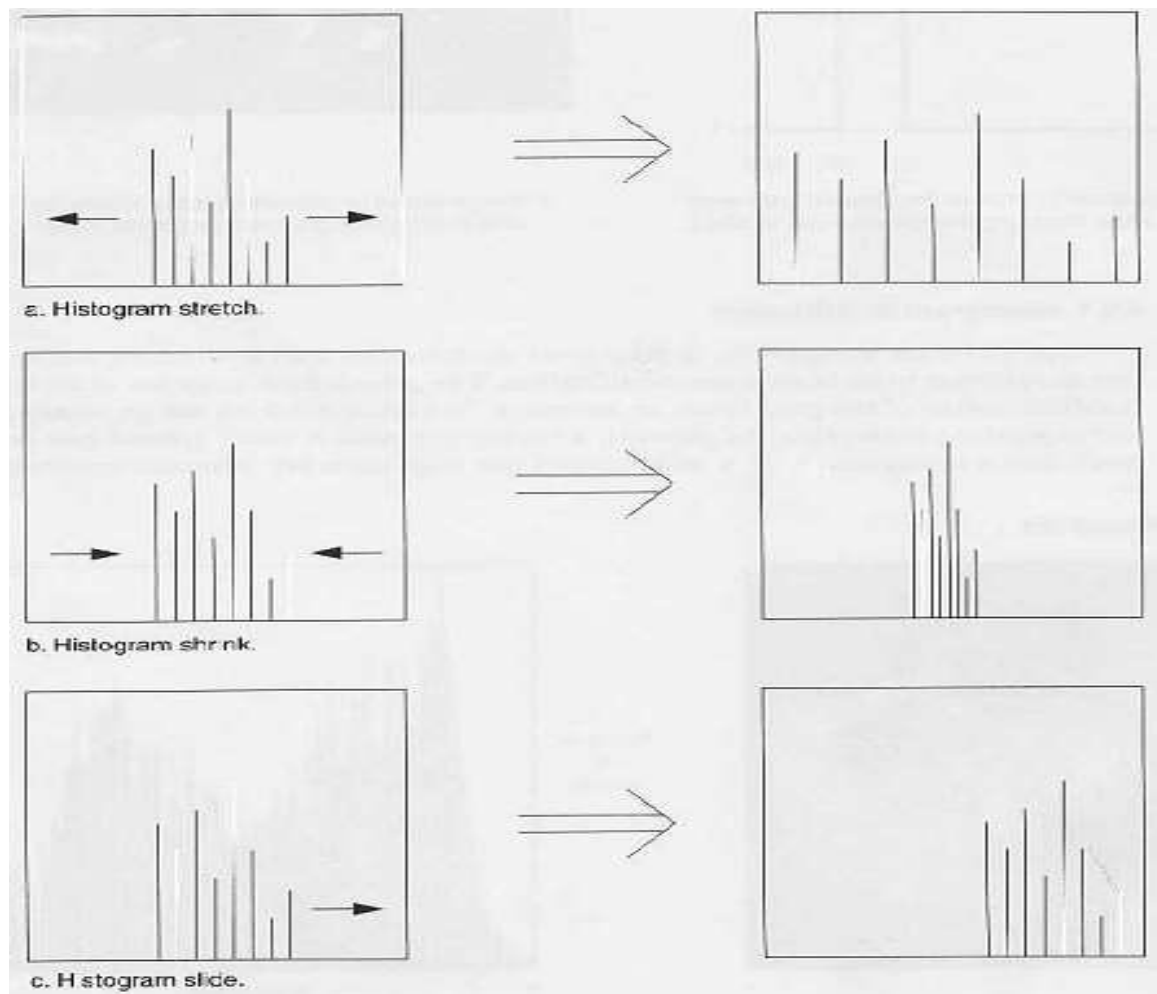


Figure2: histogram modification

1- Histogram stretching (Contrast stretching):

The mapping function for **histogram stretch** can be found by the following equation:

$$\text{Stretch}(I(r, c)) = \left[\frac{I(r, c) - I(r, c)_{\min}}{I(r, c)_{\max} - I(r, c)_{\min}} \right] [MAX - MIN] + MIN.$$

Where, $I(r, c)_{\max}$ is the largest gray-level in the image $I(r, c)$. $I(r, c)_{\min}$ is the smallest gray-level in the image $I(r, c)$. MAX and MIN correspond to the maximum and minimum gray_level values possible (for an 8-bit image these are 255 and 0). This equation will take an image and stretch the histogram across the entire gray-level range which has the effect of increasing the contrast of a low contrast image (see figure (3) of histogram stretching).

Example: Suppose an image with the histogram shown in the table and the figure (3):

Gray level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	15	0	0	0	0	70	110	45	70	35	0	0	0	0	0	15

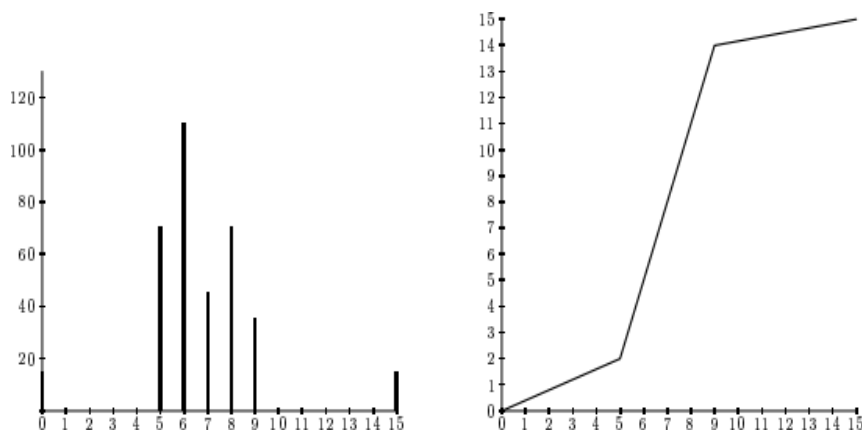


Figure 3: A histogram of a poorly contrasted image, and a stretching function.

The gray level 5-9 according the gray level 2-14. Apply the equation to get the new gray level.

$$J = \left[\frac{(14-2)}{(9-5)} \right] (i-5) + 2$$

where i is the original grey level and j its result after the transformation

i	5	6	7	8	9
j	2	5	8	11	14

and the corresponding histogram in the figure (4).

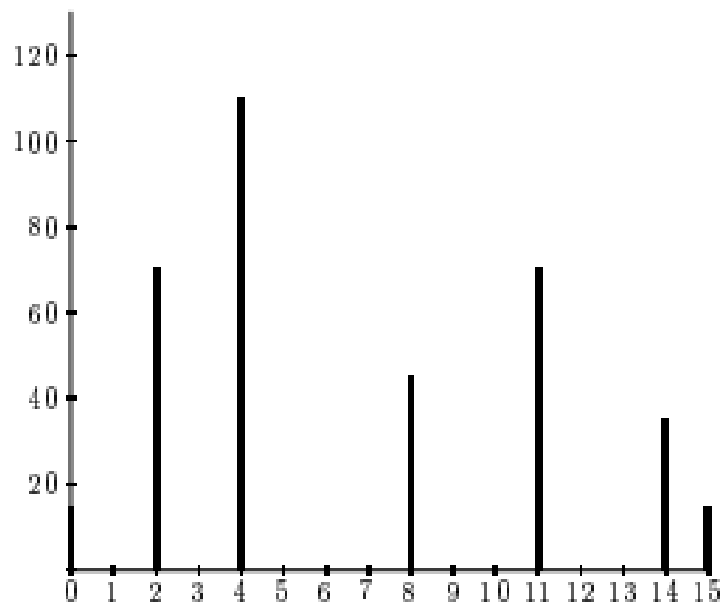
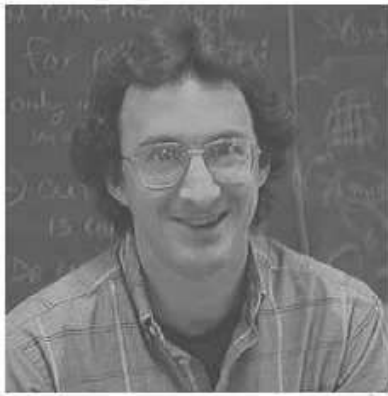
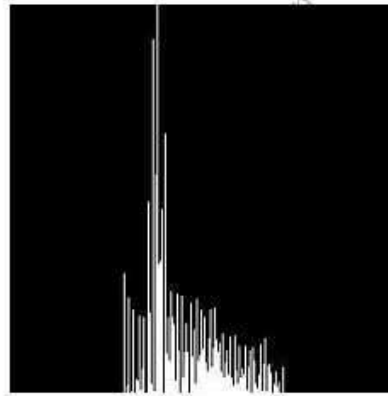


Figure 4: Histogram stretching



Low-contrast image



Histogram of low-contrast image

See

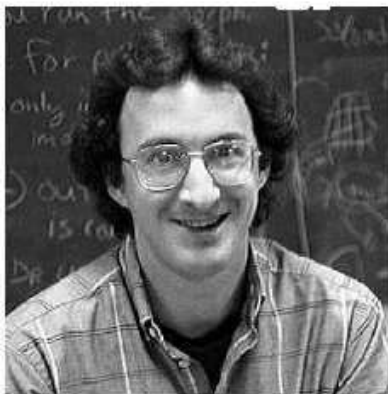
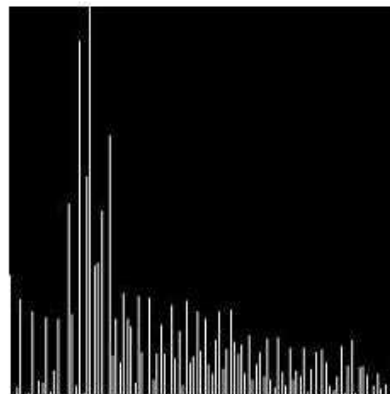


Image after histogram stretching



Histogram of image after stretching

examples in the figure (5):-

Figure(5): histogram stretching

Histogram Shrink

The opposite of a histogram stretch is a histogram shrink, which will decrease image contrast by compressing the gray levels. The mapping function for a **histogram shrinking** can be found by the following equation:

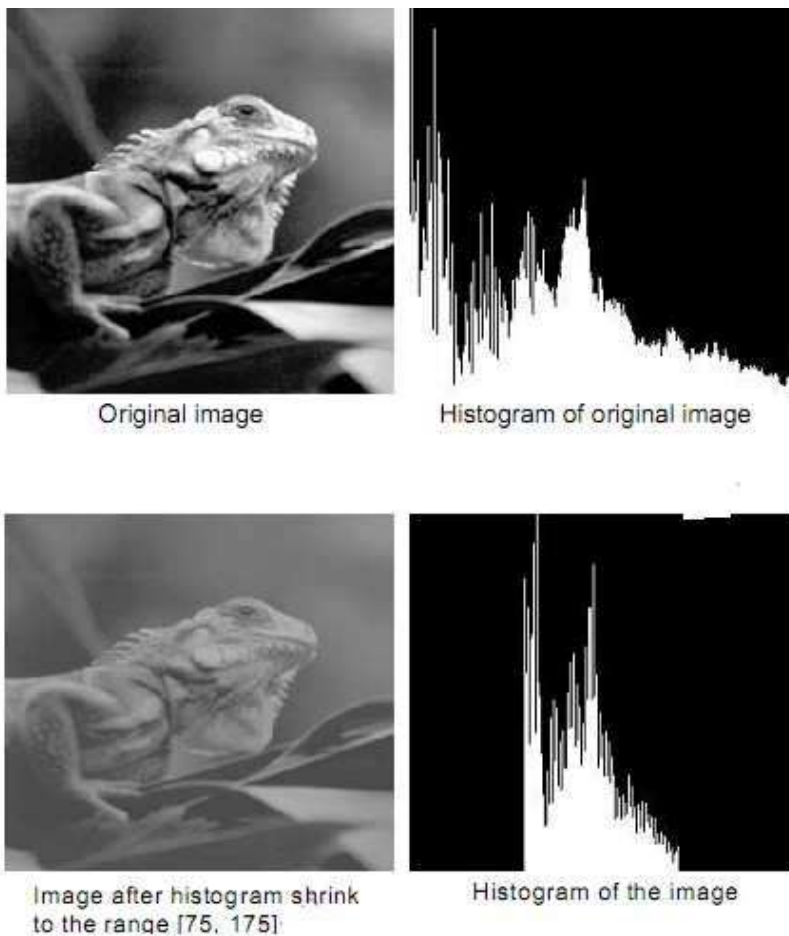
$$\text{Shrink}(I(r,c)) = \left[\frac{\text{shrink}_{\max} - \text{shrink}_{\min}}{I(r,c)_{\max} - I(r,c)_{\min}} \right] [I(r,c) - I(r,c)_{\min}] + \text{shrink}_{\min}$$

Where

$I(r,c)_{\max}$ is the largest gray-level value in the image $I(r,c)$

$I(r,c)_{\min}$ is the smallest gray-level value in $I(r,c)$

shrink_{\max} and shrink_{\min} correspond to the maximum and minimum desired in the compressed histogram. In general, this process produces an image of reduced contrast and may not seem to be useful an image enhancement (see figure (6) of shrink histogram).



Figure(6) Histogram Shrink

Histogram Sliding

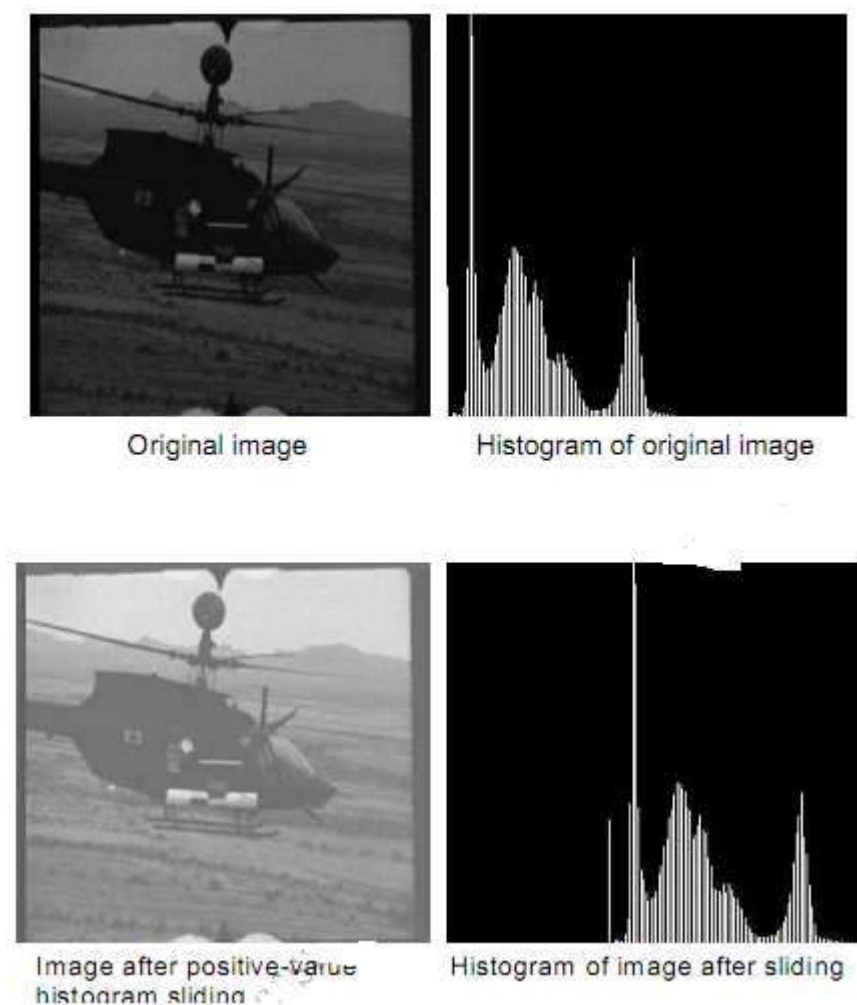
The histogram slide techniques can be used to make an image either

darker or lighter but retain the relationship between gray-level values. This can be accomplished by simply adding or subtracting a fixed number for all the gray-level values, as follows:

$$\text{Slide } (I(r,c)) = I(r,c) + \text{OFFSET.}$$

Where OFFSET values is the amount to slide the histogram.

In this equation, a positive OFFSET value will increase the overall brightness; where as a negative OFFSET will create a darker image, figure (7) shows histogram sliding.



Figure(7) Histogram Sliding