Lectures 6: **Histograms Processing**

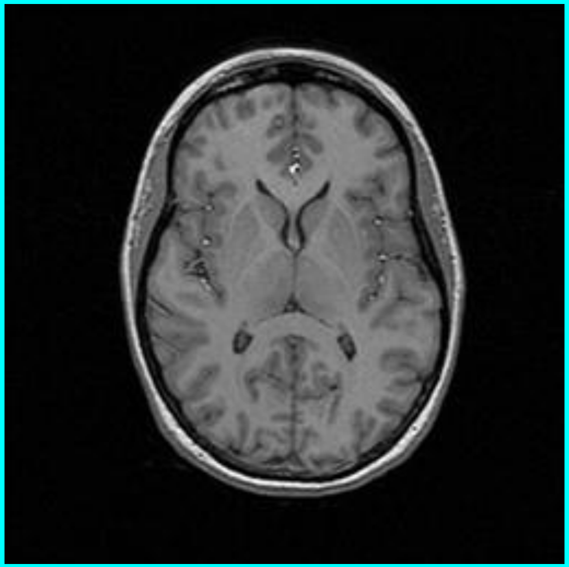
-Equalization; Matching;

- Statistics: n-th moments, variance and local statistics;

- Image Averaging.

***Experiments with software developed by students of this class- 2005, 2007.**

Histograms Processing



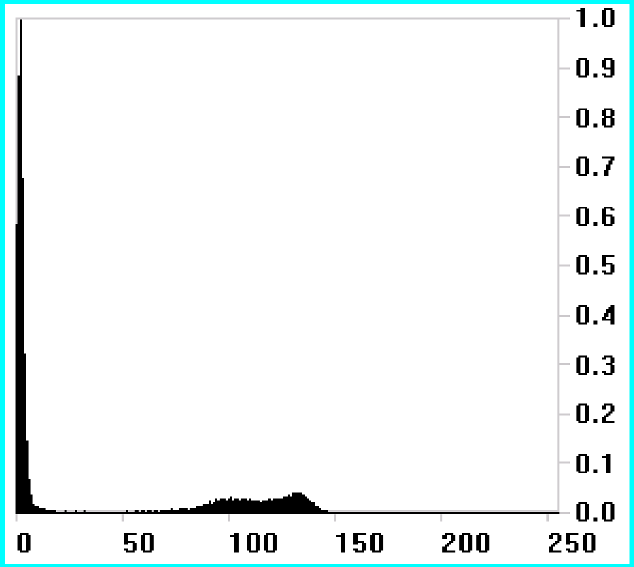


Figure 1. a) An MRI image – brain section;

b) The histogram of the image.

Histograms Matching Algorithm

Recalling that the s_ks are the values of the histogram-equalized image, we may summarize the histogram-specification procedure as follows:

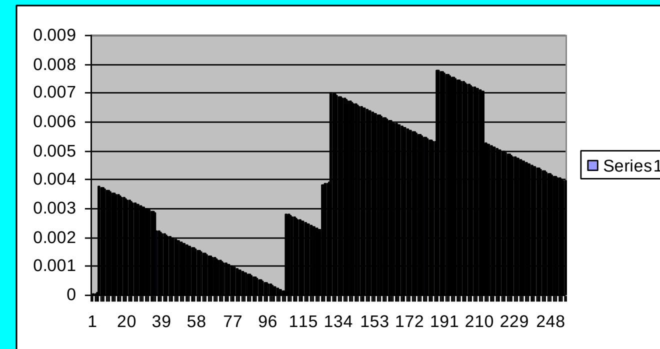
1. Compute the histogram $p_r(r)$ of the given image, and use it to find the histogram equalization transformation in Eq. (3.3-13). Round the resulting values, s_k, to the integer range $[0, L-1]$.
2. Compute all values of the transformation function G using the Eq. (3.3-14) for $q = 0, 1, 2, \ldots, L-1$, where $p_z(z_i)$ are the values of the specified histogram. Round the values of G to integers in the range $[0, L-1]$. Store the values of G in a table.
3. For every value of s_k, $k = 0, 1, 2, \ldots, L-1$, use the stored values of G from step 2 to find the corresponding value of z_q so that $G(z_q)$ is closest to s_k and store these mappings from s to z. When more than one value of z_q satisfies the given s_k (i.e., the mapping is not unique), choose the smallest value by convention.
4. Form the histogram-specified image by first histogram-equalizing the input image and then mapping every equalized pixel value, s_k, of this image to the corresponding value z_q in the histogram-specified image using the mappings found in step 3. As in the continuous case, the intermediate step of equalizing the input image is conceptual. It can be skipped by combining the two transformation functions, T and G^{-1}, as Example 3.8 shows.

- **Digital Image Processing, 3rd E, by Gonzalez, Woods**

Exp. Results Histogram Matching and Equalization

a)

b)



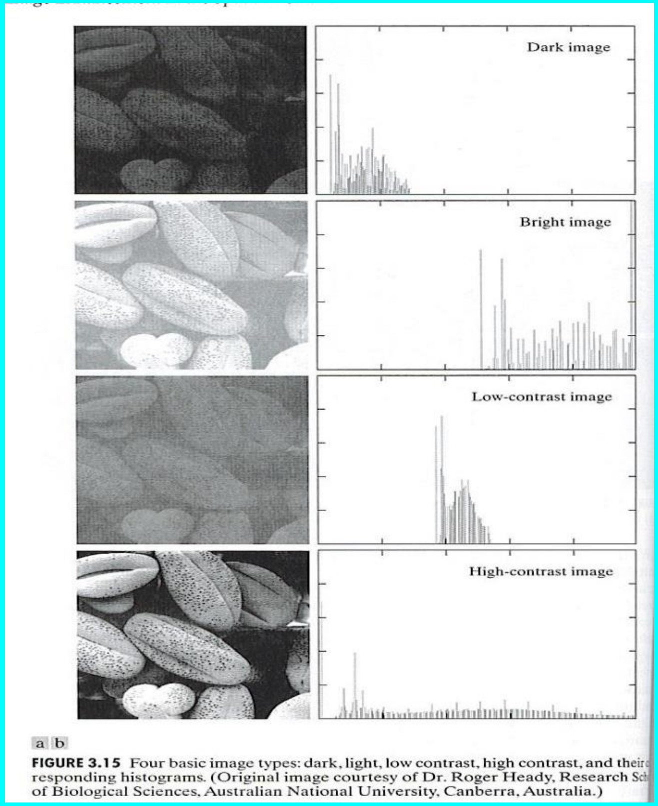
c)

d)

Figure 2. a) The original image; **b)** histogram; **c)** the image from (a) after matching with the histogram from b); **d)** the image from (a) after equalization.

Experiments performed with a software coded by Nilkantha Aryal in a team with Sharon Rushing-2005.

Histograms Processing



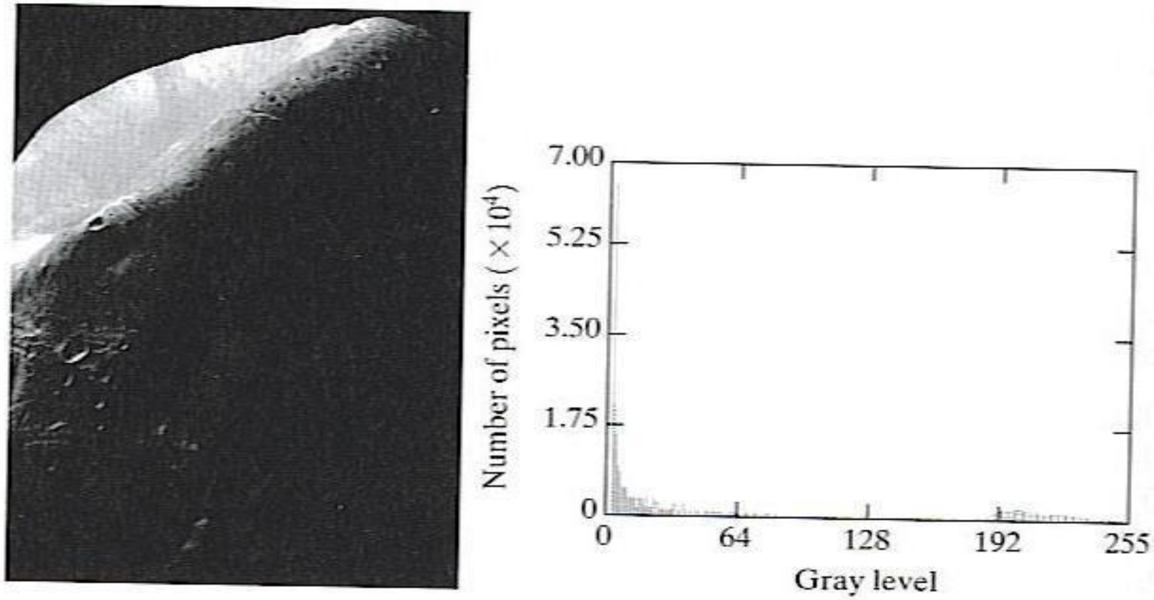
a) b)

Figure 3. a) Images and their histograms;

b) Central column histogram Equalized Images; right

Column shows their Histograms. One could tell that images with good contrast have normal distribution of the gray levels. (**Digital Image Processing, 2nd E, by Gonzalez, Woods**).

Histograms Processing

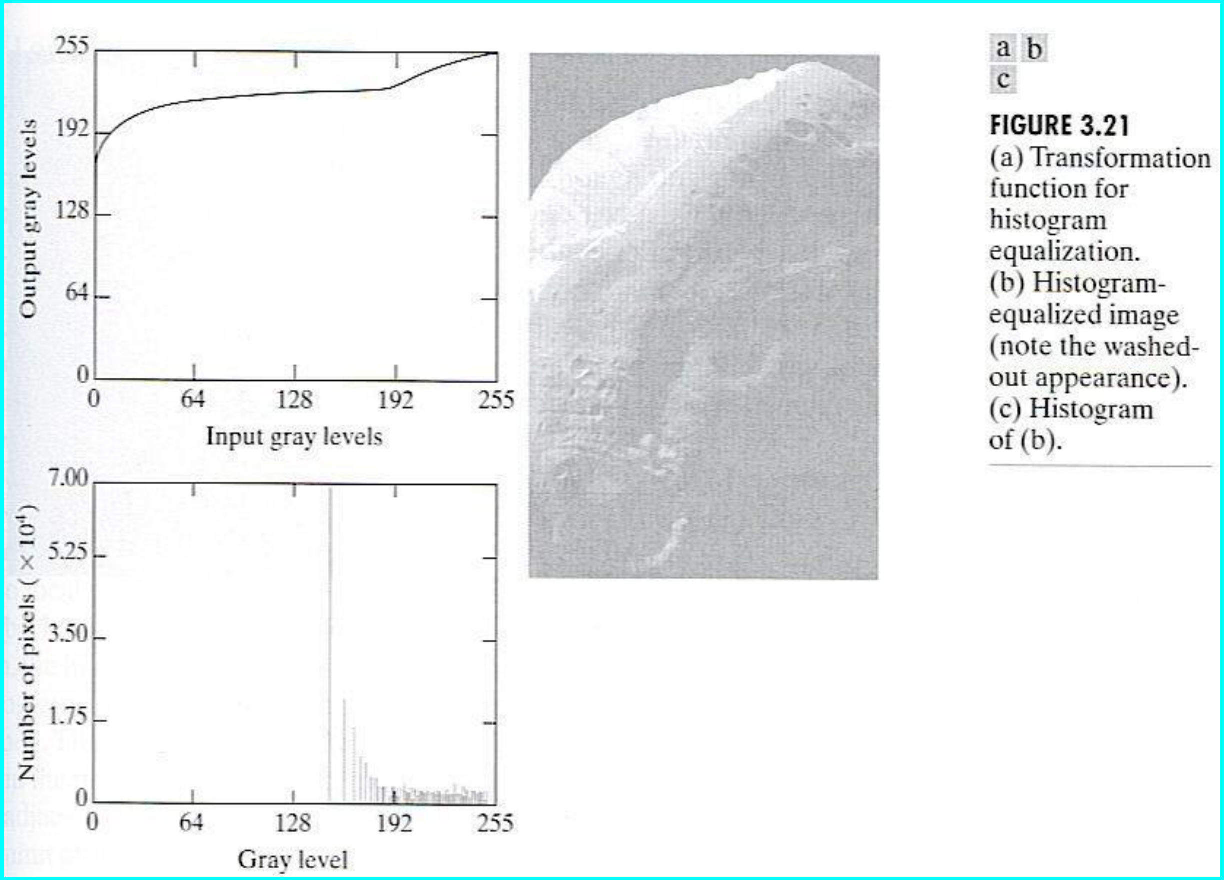


a b

FIGURE 3.20 (a) Image of the Mars moon Phobos taken by NASA's *Mars Glob[e] Surveyor*. (b) Histogram. (Original image courtesy of NASA.)

Figure 4. left) An image with a bad contrast; **right)** its histogram where most of the gray levels are distributed at the dark zone of the histogram. (Digital Image Processing, 2nd E, by Gonzalez, Richard)**.**

Histograms Processing



a) b)
c)

Figure 5. a) the curve used for histogram equalization; **b)** the image from Fig.4 after equalization; **c)** its histogram.

(Digital Image Processing, 2nd E, by Gonzalez, Richard).

Histograms Processing

a c
b
d

FIGURE 3.22
(a) Specified histogram.
(b) Curve (1) is from Eq. (3.3-14), using the histogram in (a); curve (2) was obtained using the iterative procedure in Eq. (3.3-17).
(c) Enhanced image using mappings from curve (2).
(d) Histogram of (c).

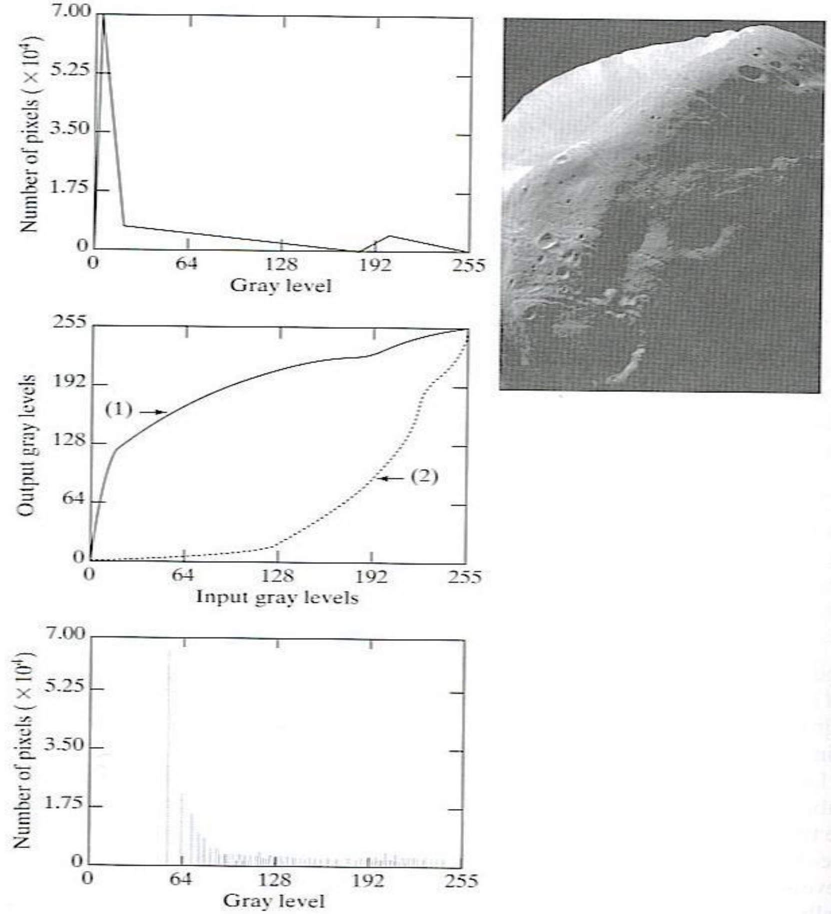


Figure 6. Image enhancement using histograms matching.

Image Enhancement by Local Statistics

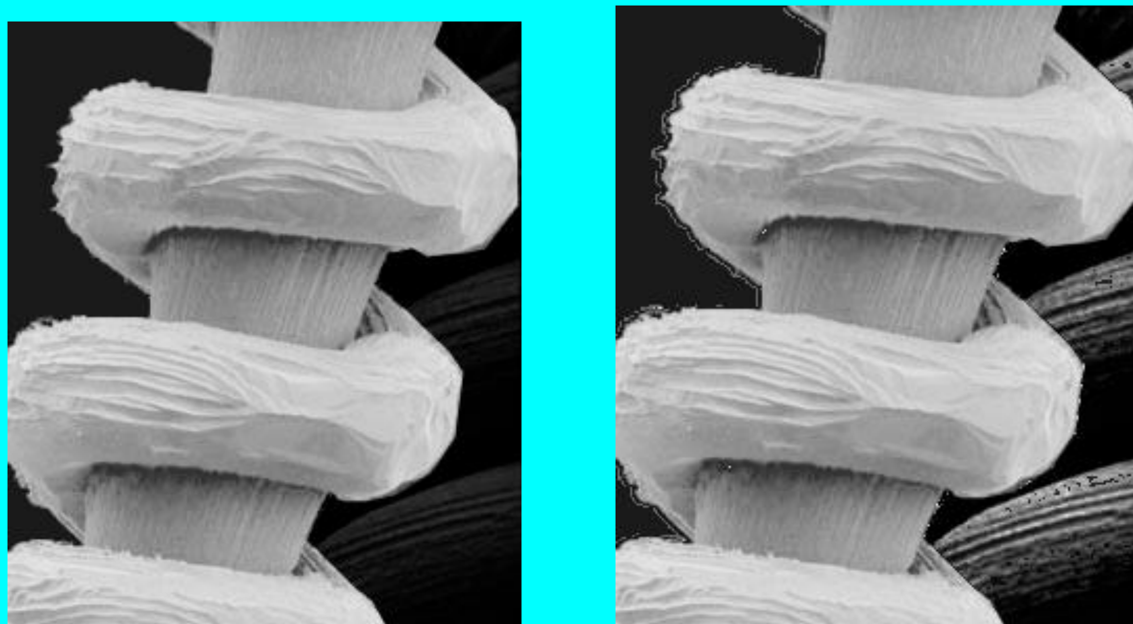


Figure 7: (left) An image with low contrast right side. (right) The enhanced image by a local statistic image studio coded in C sharp, Spring 2007, by Josh D. Anderton, In a joint project with Renee Townsend.

The original image is a courtesy of Digital Image Processing, 2nd E, by Gonzalez, Richard

Image Enhancement by Local Statistics- continuation of Lecture 3

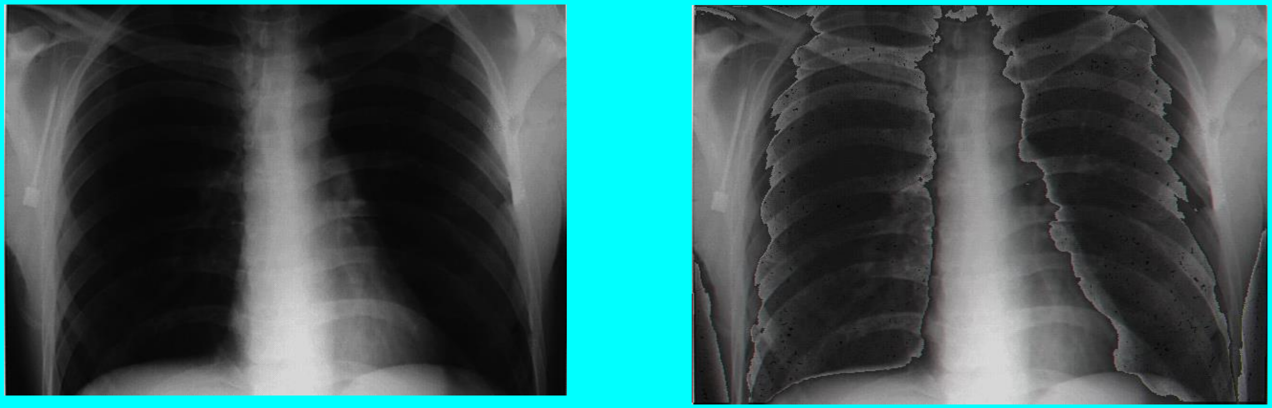


Figure 8: (left) An X-ray image of a chest. (right) The enhanced image by a local statistic image studio coded in C sharp, Spring 2007, by Josh D. Anderton, In a joint project with Renee Townsend.

Image Planes

Figure 9. a) the original image; **b) - i)** planes 1 to 8.

Courtesy of Digital Image Processing, 2nd E, by Gonzalez, Richard

Arithmetic Logic Operations

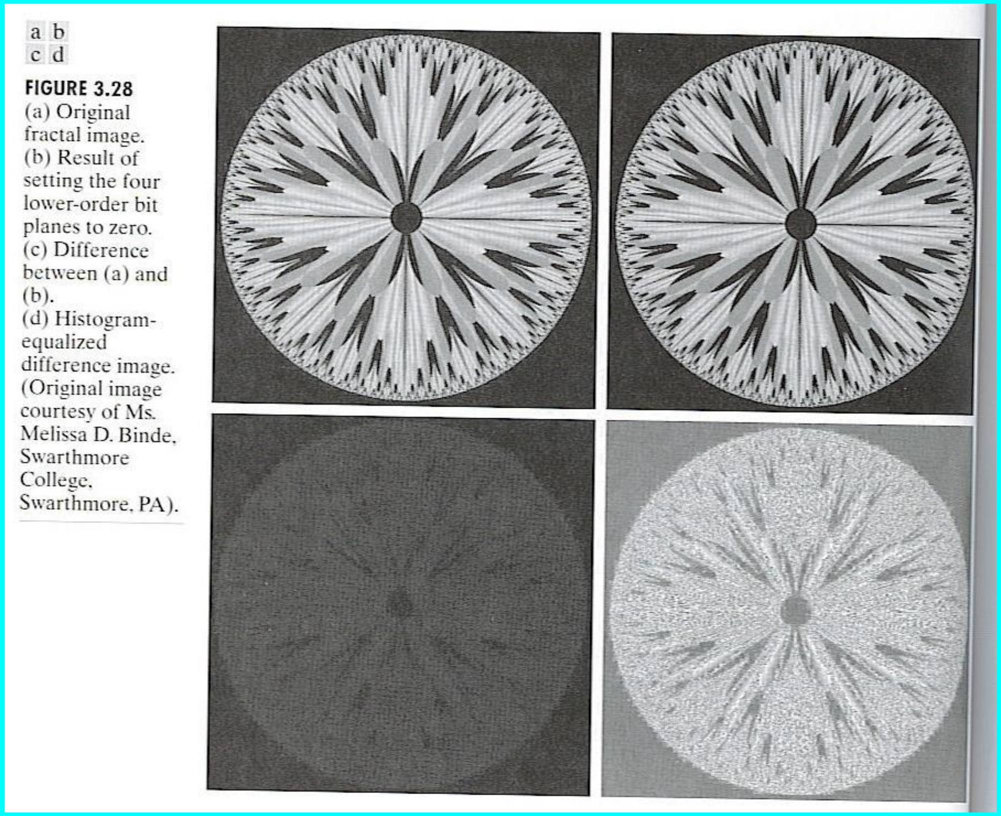


Figure 10. a) upper left-the original image; b) The lower 4 bits are set 0; c) Subtraction of the new image from the original;

d) Equalized image from c). (Courtesy of Digital Image Processing, 2nd E, by Gonzalez, Richard).

Image Averaging

a) b)
c) d)
e) f)

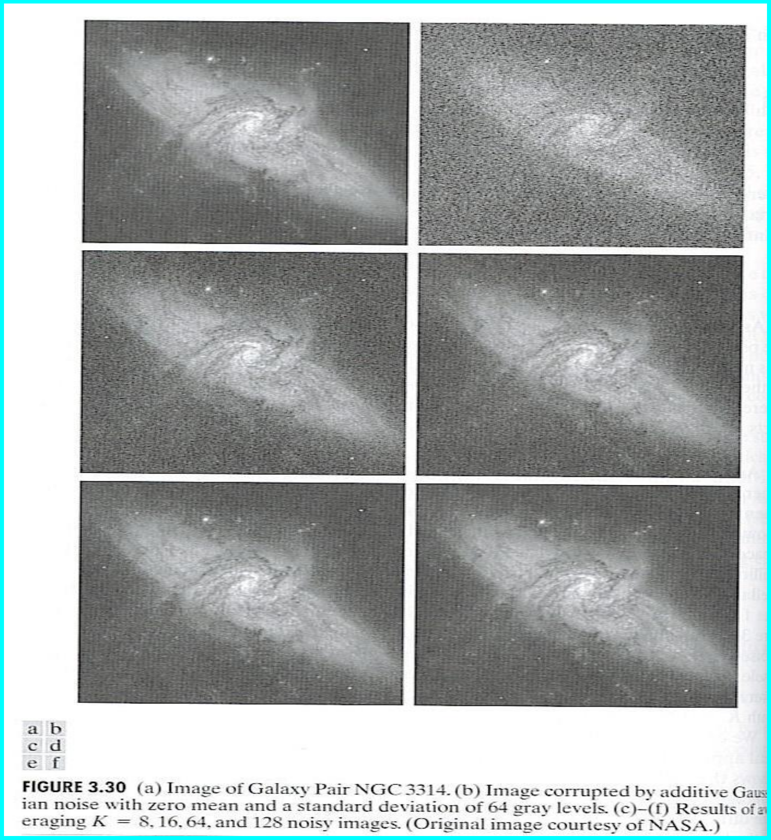
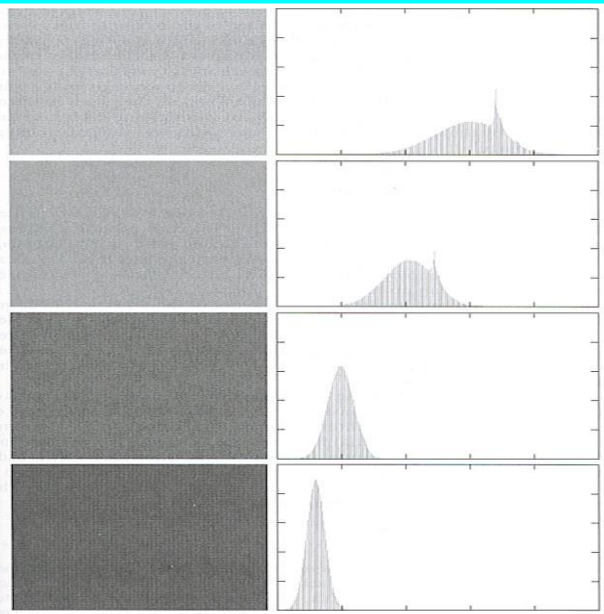


Figure 11. a) The original image; b) the image from (a) with added Gaussian noise: Mean=0, and deviation 64 gray level; c)-f) results averaging K=8,16,64,128.
(Digital Image Processing, 2nd E, by Gonzalez, Richard).

Image Averaging

a)
b)
c)
d)



a b

FIGURE 3.31 (a) From top to bottom: Difference images between Fig. 3.30(a) and the four images in Figs. 3.30(c) through (f), respectively. (b) Corresponding histograms.

As in the case of image subtraction, adding two or more 8-bit images requires ecial care when it comes to displaying the result on an 8-bit display. The values in e sum of K, 8-bit images can range from 0 to $255 \times K$. Scaling back to 8 bits in is case consists simply of dividing the result by K. Naturally, some accuracy will lost in the process, but this is unavoidable if the display has to be limited to 8 bits.

Figure 12. a)-d) The result of subtracting the images given in Fig.11c)-f) from the image in 10a). Histograms of the result images.

(Digital Image Processing, 2nd E, by Gonzalez, Richard).