

Point Processing



15-463: Computational Photography
Alexei Efros, CMU, Fall 2008

Image Processing

image filtering: change **range** of image

$$g(x) = h(f(x))$$

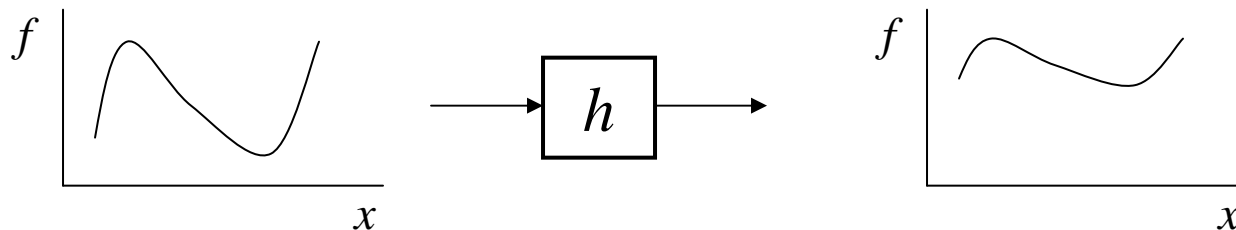


image warping: change **domain** of image

$$g(x) = f(h(x))$$

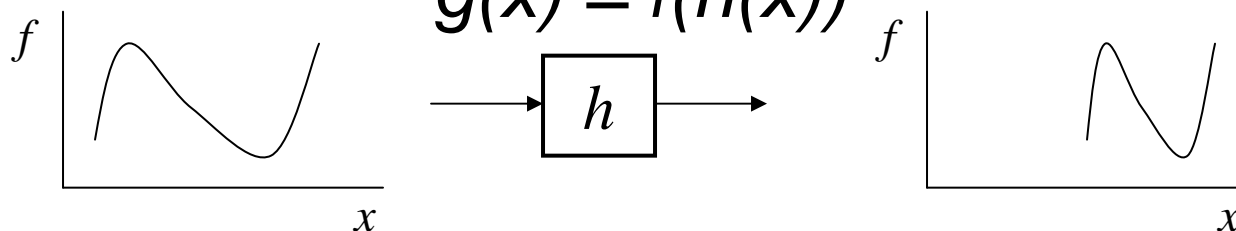


Image Processing

image filtering: change **range** of image

$$g(x) = h(f(x))$$

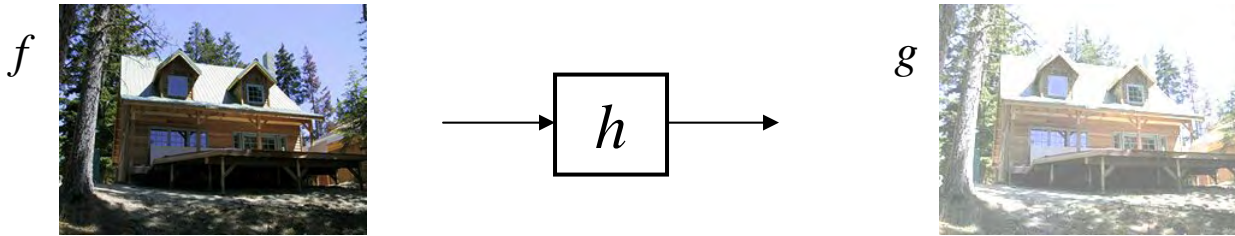
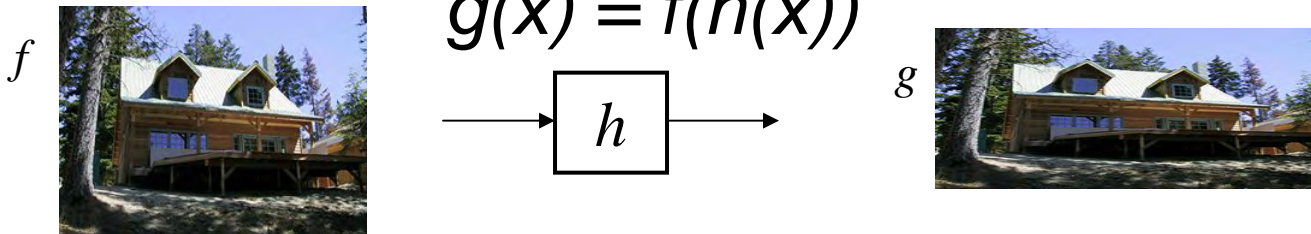


image warping: change **domain** of image

$$g(x) = f(h(x))$$



Point Processing

The simplest kind of range transformations are these independent of position x,y :

$$g = t(f)$$

This is called point processing.

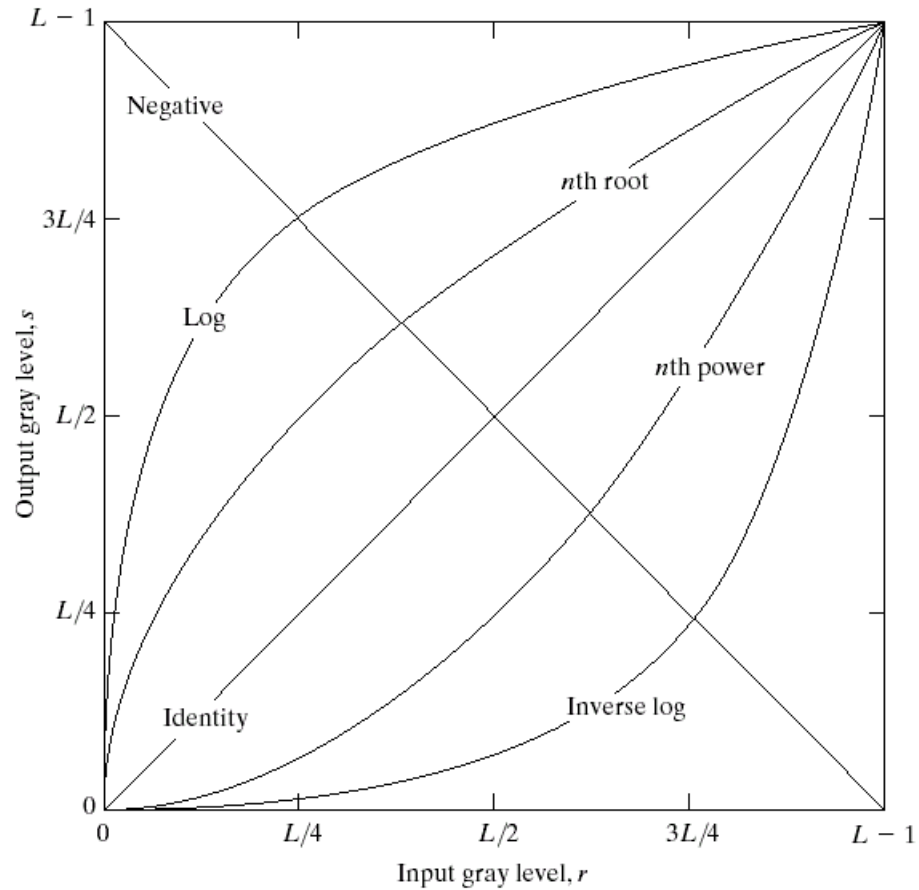
What can they do?

What's the form of t ?

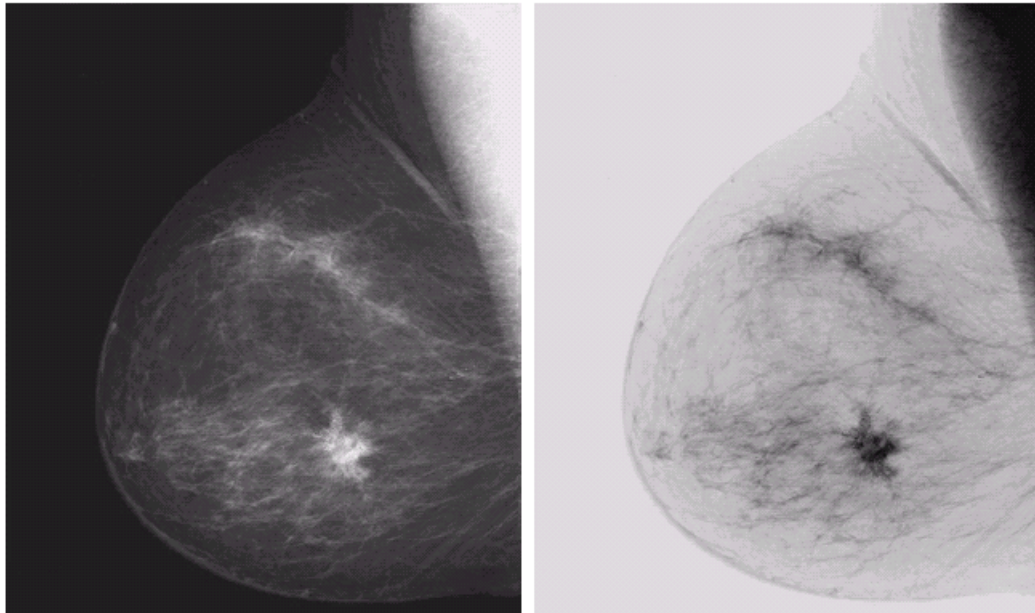
Important: every pixel for himself – spatial information completely lost!

Basic Point Processing

FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.



Negative



a b

FIGURE 3.4

(a) Original digital mammogram.
(b) Negative image obtained using the negative transformation in Eq. (3.2-1).
(Courtesy of G.E. Medical Systems.)

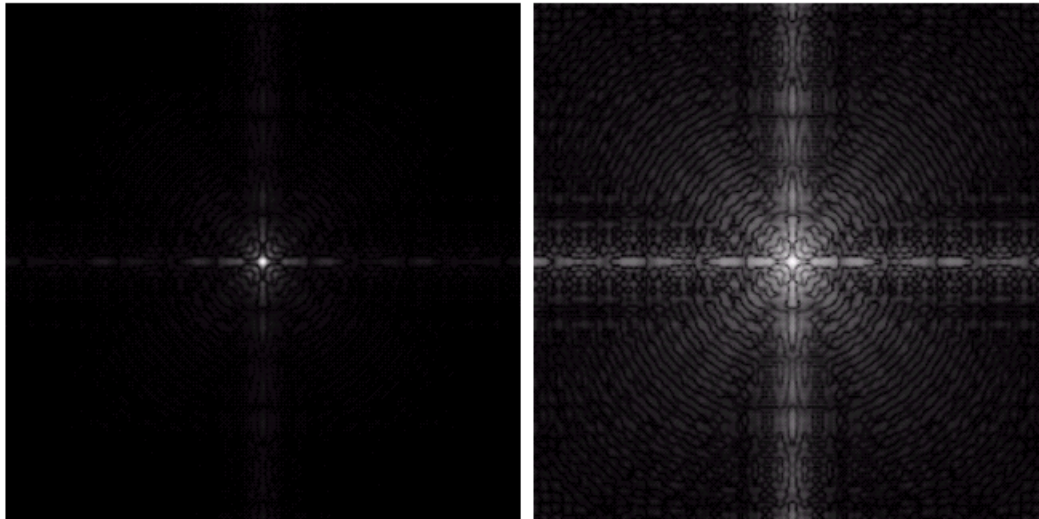
Log

a b

FIGURE 3.5

(a) Fourier spectrum.

(b) Result of applying the log transformation given in Eq. (3.2-2) with $c = 1$.



Power-law transformations

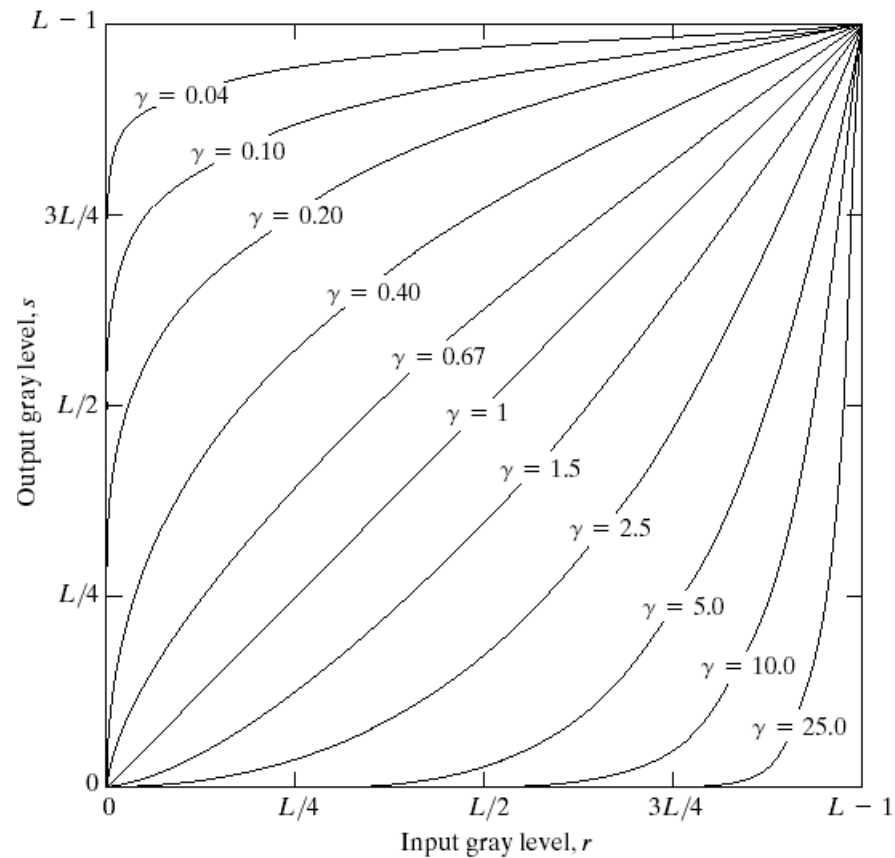


FIGURE 3.6 Plots of the equation $s = cr^\gamma$ for various values of γ ($c = 1$ in all cases).

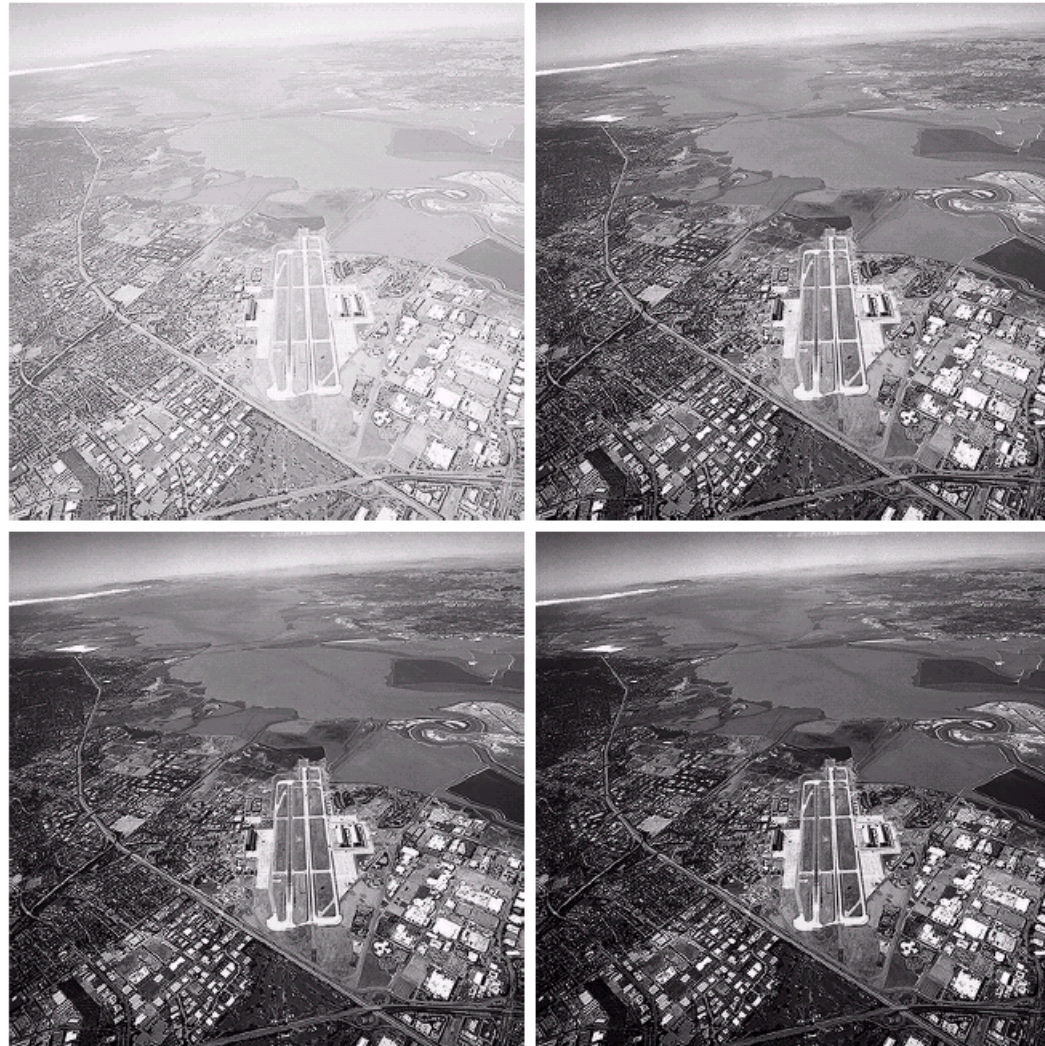
$$s = cr^\gamma$$

Image Enhancement

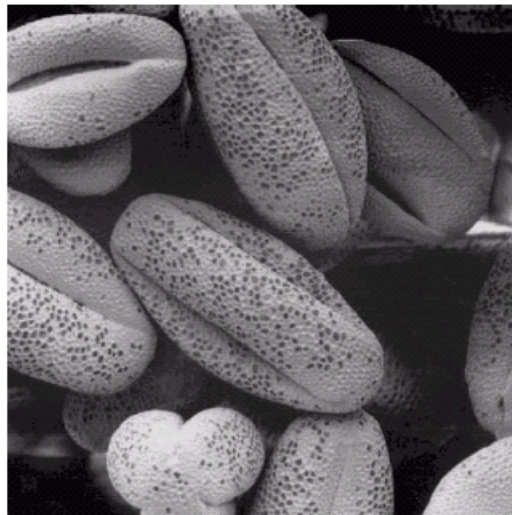
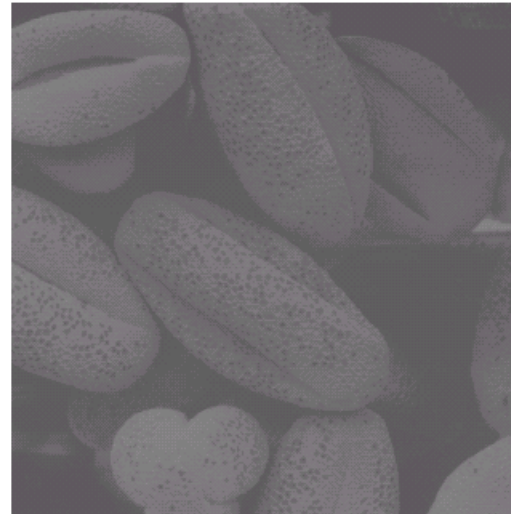
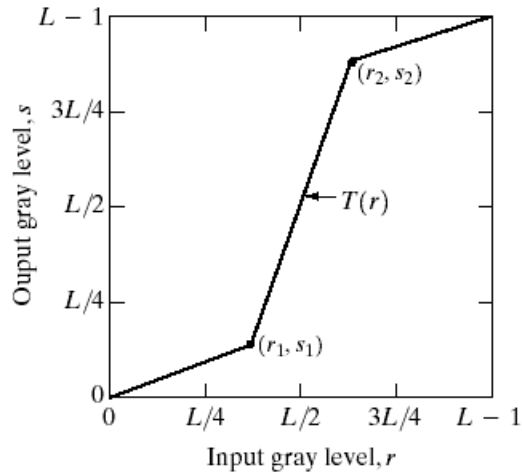
a b
c d

FIGURE 3.9

(a) Aerial image.
(b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0,$ and $5.0,$ respectively. (Original image for this example courtesy of NASA.)



Contrast Stretching

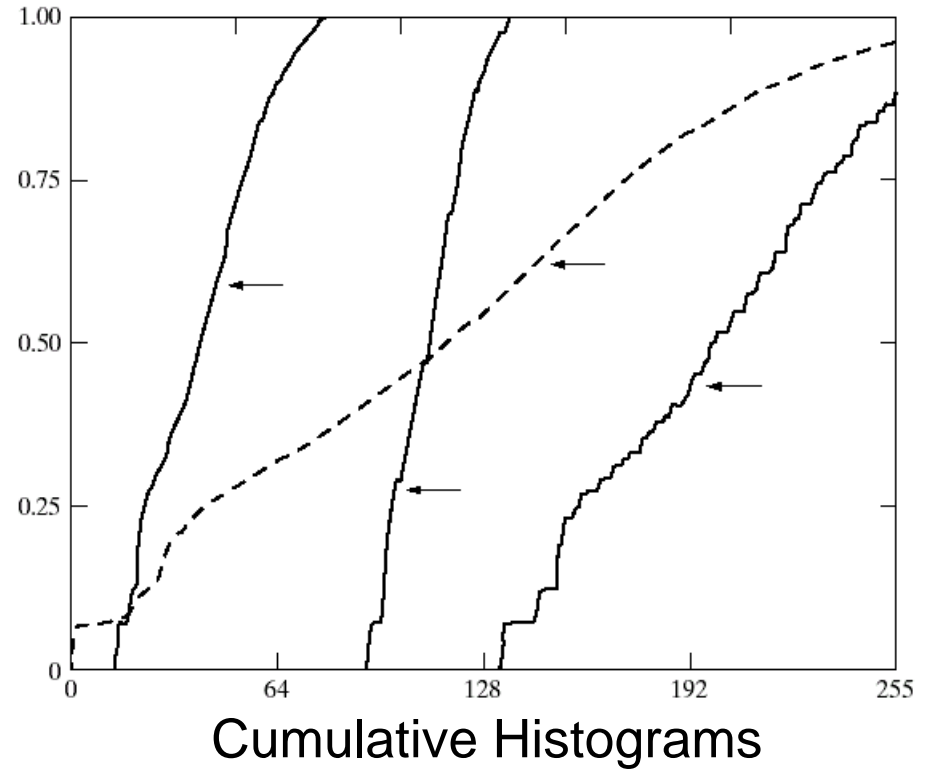
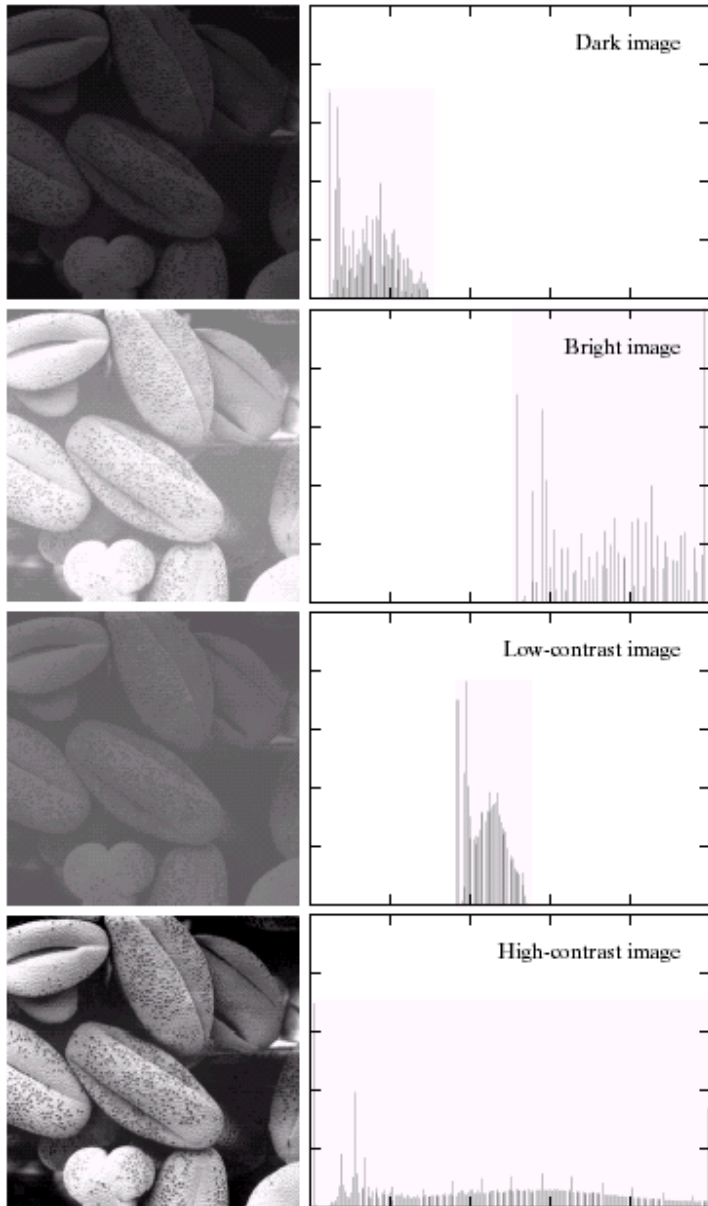


a b
c d

FIGURE 3.10

Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

Image Histograms

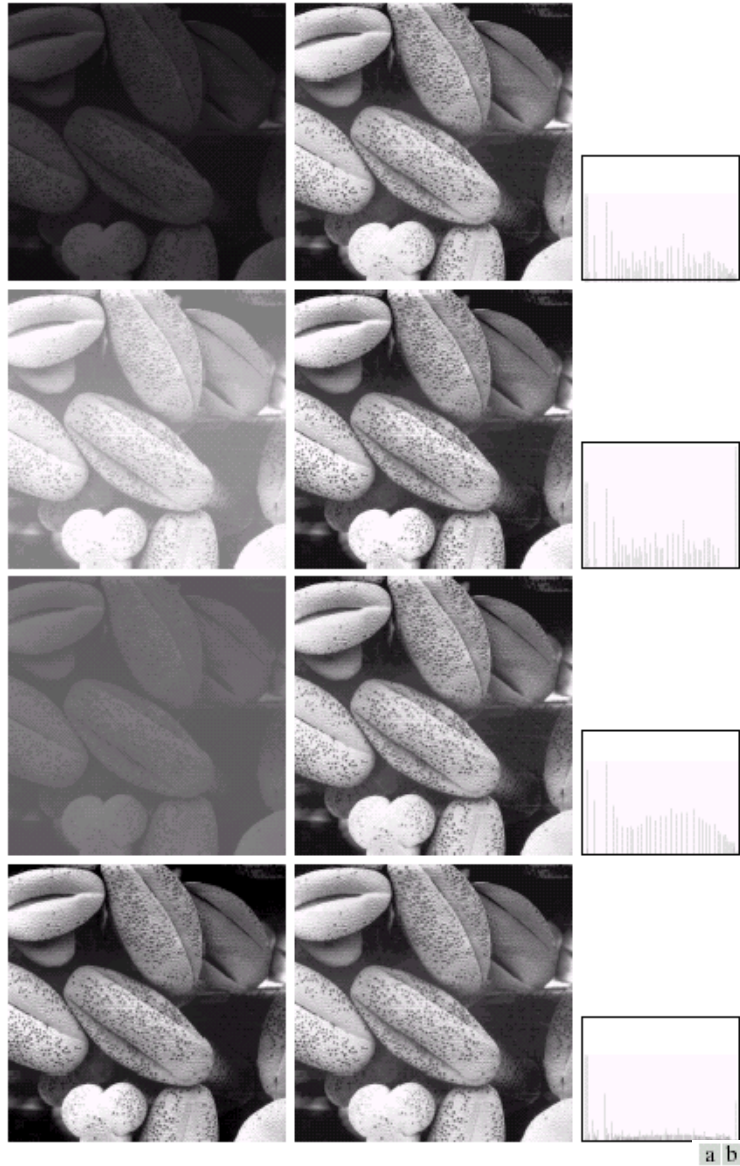


$$s = T(r)$$

a b

FIGURE 3.15 Four basic image types: dark, light, low contrast, high contrast, and their corresponding histograms. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

Histogram Equalization

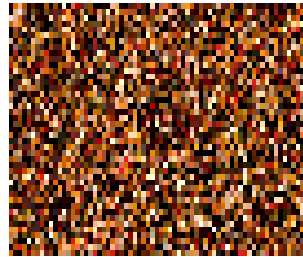
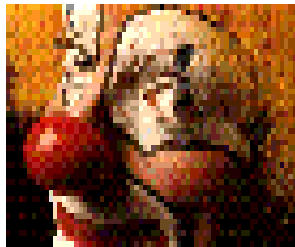


a b c

FIGURE 3.17 (a) Images from Fig. 3.15. (b) Results of histogram equalization. (c) Corresponding histograms.

Limitations of Point Processing

Q: What happens if I reshuffle all pixels within the image?



A: It's histogram won't change. No point processing will be affected...