Point Processing

15-463: Computational Photography
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Some figures from Steve Seitz, and Gonzalez et al.
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!
FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.
Negative

**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.)
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

\[ s = cr^\gamma \]

**FIGURE 3.6** Plots of the equation \( s = cr^\gamma \) for various values of \( \gamma \) (\( c = 1 \) in all cases).
FIGURE 3.9
(a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0, \text{and} 5.0$, respectively. (Original image for this example courtesy of NASA.)
Contrast Stretching

![Graph showing the transformation function T(r) with input gray level r on the x-axis and output gray level s on the y-axis. Points (r1, s1) and (r2, s2) are marked on the graph.]
Image Histograms

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

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…