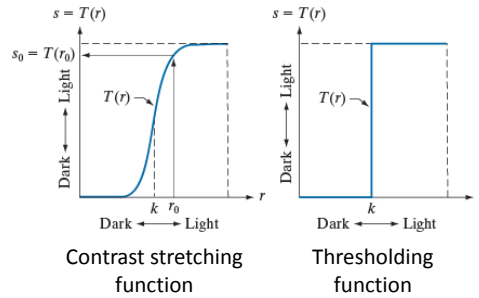


Intensity Transformations

Image Processing
CSE 166
Lecture 3

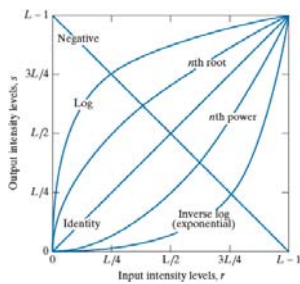
Intensity transformations



CSE 166, Fall 2017

2

Intensity transformations



Some basic transformation functions

CSE 166, Fall 2017

3

Negative transformation

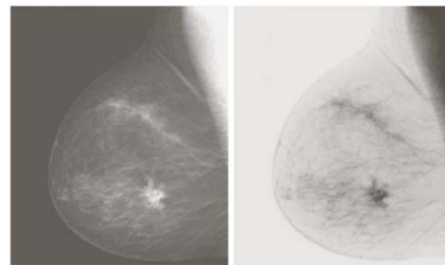


FIGURE 3.4
(a) A digital mammogram.
(b) Negative image obtained using Eq. (3-3).
(Image (a) Courtesy of General Electric Medical Systems.)

CSE 166, Fall 2017

4

Gamma transformation

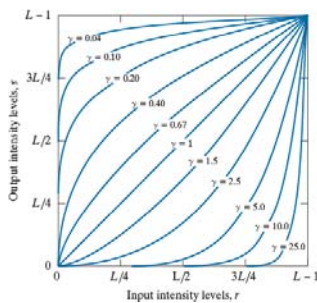


FIGURE 3.6
Plots of the gamma equation $s = cr^\gamma$ for various values of γ ($c = 1$ in all cases). Each curve was scaled independently so that all curves would fit in the same graph. Our interest here is on the shapes of the curves, not on their relative values.

CSE 166, Fall 2017

5

Gamma transformation

Dark image

$\gamma < 1$

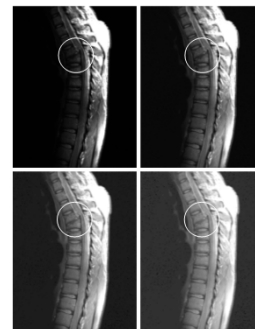


FIGURE 3.8
(a) Magnetic resonance image (MRI) of a fractured human spine (the region of the fracture is enclosed by the circles). (b)-(d) Results of applying the transformation in Eq. (3-5) with $c = 1$ and $\gamma = 0.6, 0.4,$ and 0.3 , respectively. (Original image courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

CSE 166, Fall 2017

6

Gamma transformation

Light image

$\gamma > 1$

FIGURE 3.10
 (a) Aerial image. (b)-(d) Results of applying the transformation in Eq. (3-5) with $\gamma = 3.0, 4.0,$ and $5.0,$ respectively ($c = 1$ in all cases.) (Original image courtesy of NASA.)

CSE 166, Fall 2017 7

Piecewise-linear transformations

- Contrast stretching
- Intensity-level slicing
- Bit-plane slicing

CSE 166, Fall 2017 8

Contrast stretching

FIGURE 3.10
 Contrast stretching. (a) Piecewise linear transformation function. (b) A low-contrast electron microscope image of pills, magnified 700 times. (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.)

CSE 166, Fall 2017 9

Intensity-level slicing

FIGURE 3.11
 (a) This transformation function highlights range $[A, B]$ and reduces all other intensities to a lower level. (b) This function highlights range $[A, B]$ and leaves other intensities unchanged.

CSE 166, Fall 2017 10

Bit-plane slicing

FIGURE 3.14
 (a) An 8-bit grayscale image of size 837×988 pixels. (b) through (i) Bit planes 8 through 1, respectively, where plane 1 contains the least significant bit. Each bit plane is a binary image. Figure (a) is an SEM image of a trophozoite that causes a disease called giardiasis. (Courtesy of Dr. Stan Erlandson, U.S. Center for Disease Control and Prevention.)

CSE 166, Fall 2017 11

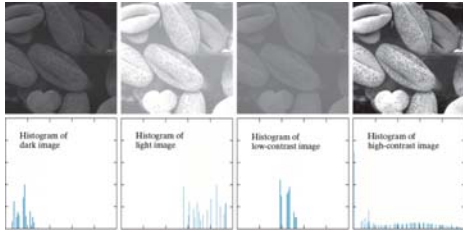
Bit-plane slicing

FIGURE 3.15
 Image reconstructed from bit planes: (a) 8 and 7; (b) 8, 7, and 6; (c) 8, 7, 6, and 5.

CSE 166, Fall 2017 12

Histogram

FIGURE 3.16 Four images types and their corresponding histograms (a) dark; (b) light; (c) low contrast; (d) high contrast. The horizontal axis of the histograms are values of r_i and the vertical axis are values of $P(r_i)$.



Similar to probability density function (pdf)

CSE 166, Fall 2017

13

Histogram equalization

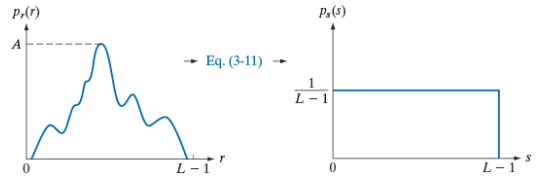


FIGURE 3.18 (a) An arbitrary PDF. (b) Result of applying Eq. (3-11) to the input PDF. The resulting PDF is always uniform, independently of the shape of the input.

CSE 166, Fall 2017

14

Histogram equalization

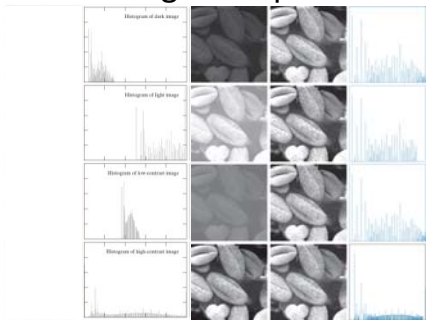


FIGURE 3.20 Left column: Images from Fig. 3.16. Center column: Corresponding histogram-equalized images. Right column: histograms of the images in the center column (compare with the histograms in Fig. 3.16).

CSE 166, Fall 2017

17

Histogram equalization

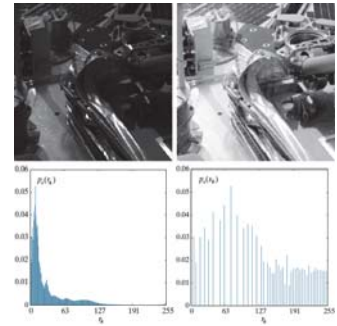


FIGURE 3.22 (a) Image from Phoenix Lander. (b) Result of histogram equalization. (c) Histogram of image (a). (d) Histogram of image (b). (Original image courtesy of NASA.)

CSE 166, Fall 2017

16

Histogram matching

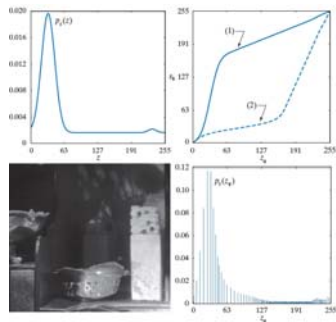


FIGURE 3.26 Histogram matching. (a) Specified histogram. (b) Transformation $G(r,s)$, labeled (1), and $G^{-1}(s,r)$, labeled (2). (c) Result of histogram specification. (d) Histogram of image (c).

CSE 166, Fall 2017

17

Local histogram equalization

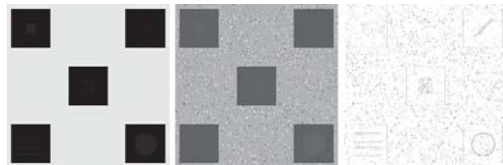


FIGURE 3.32 (a) Original image. (b) Result of global histogram equalization. (c) Result of local histogram equalization.

CSE 166, Fall 2017

18