Image Enhancement

Reading:
Chapter 3 (Spatial domain)
Chapter 4 (Frequency domain)

Image Enhancement

- Basic gray level transformations
- Histogram Modification
- Average and Median Filtering
- Frequency domain operations
- Homomorphic Filtering
- Edge enhancement

Image Enhancement

Input image → Enhancement technique → "Better" image

Application specific

- No general theory

Spatial domain

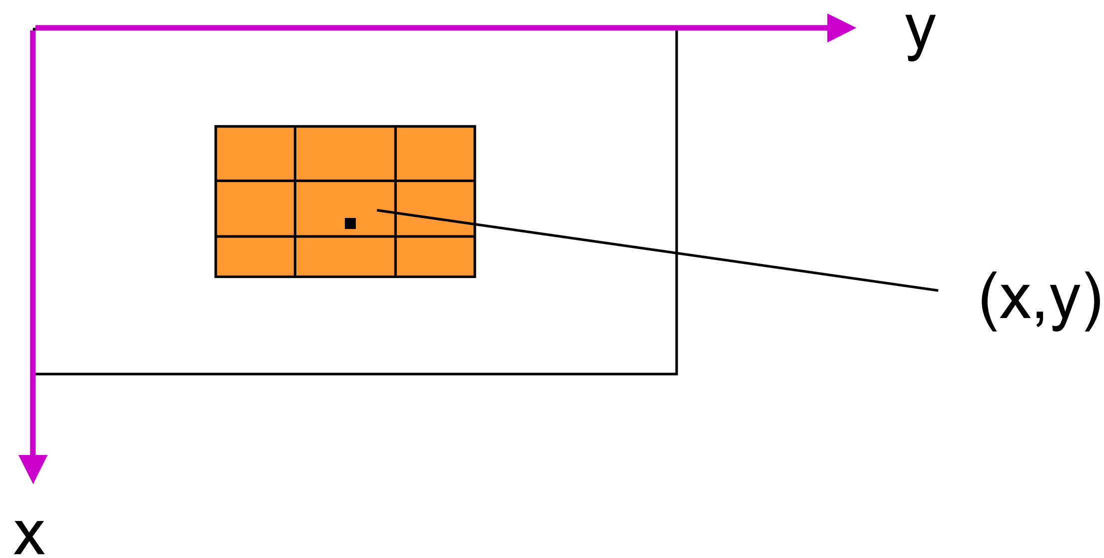
Manipulate pixel intensity directly

Frequency domain

Modify the Fourier transform

Spatial domain techniques

$$g(x,y) = T[\, f(x,y)\,]$$



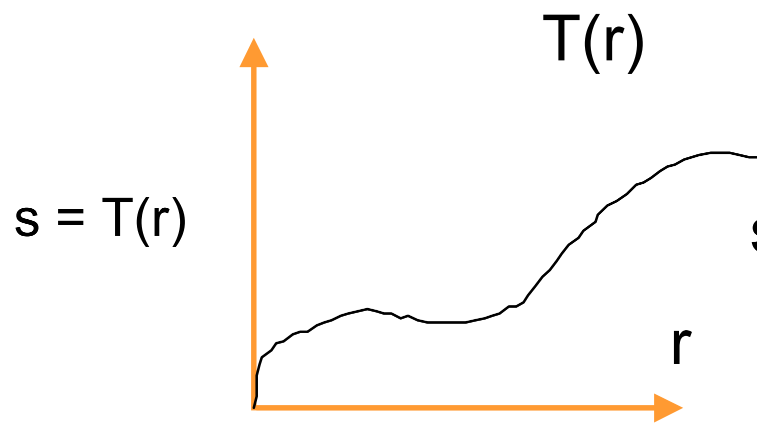
Simplest case: Neighbourhood is (x,y)

[g(.) depends only on the value of f at (x,y)]

Contrast Stretching

Example:

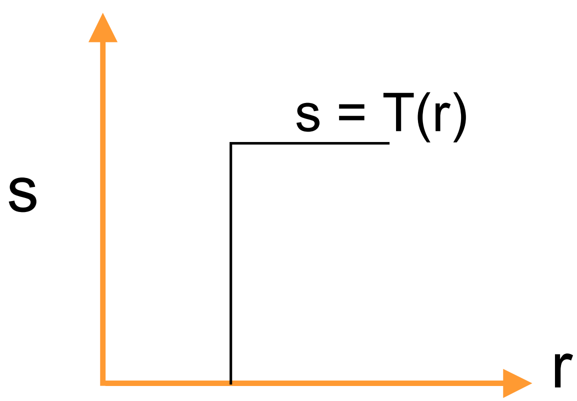
s = T (r)



s, r : Gray levels

Example of contrast stretching.

Thresholding

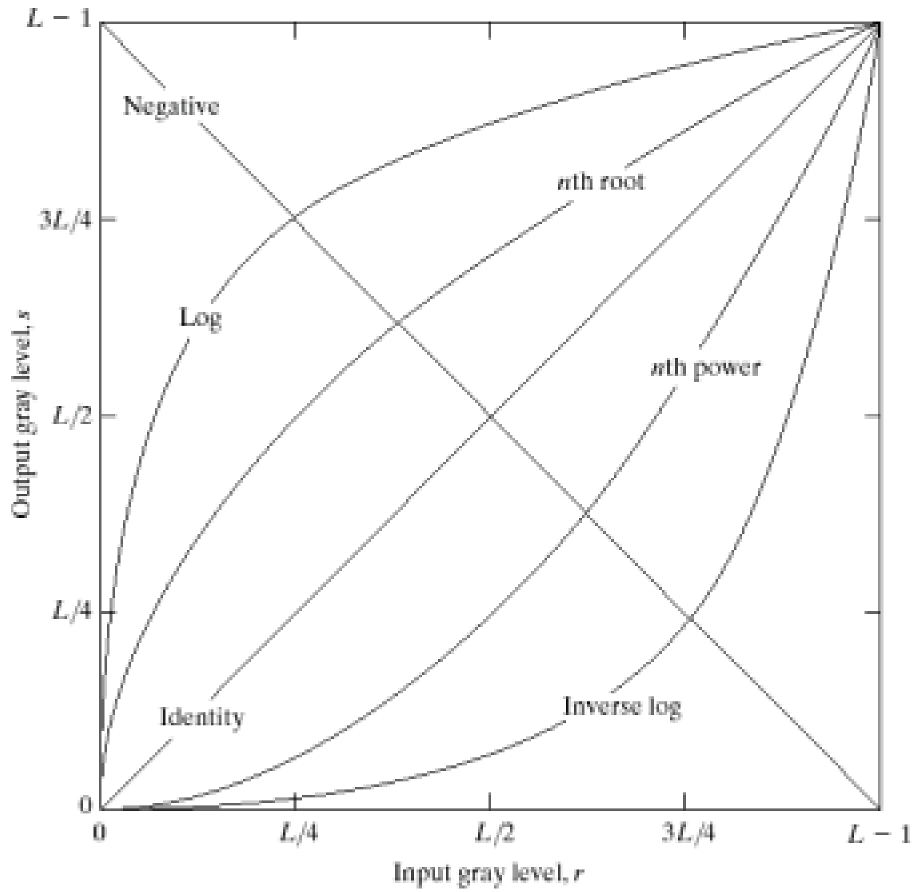


There are all point operations

hence referred to as point processing.

Figure 3.3

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



Frequency domain techniques

$$g(x,y) = h(x,y) * f(x,y)$$
$$G(u,v) = H(u,v)\ F(u,v)$$

$$g(x,y) = F^{-1}\{ H(u,v)\ F(u,v) \}$$

$h(x,y) \longrightarrow$ Spatial convolution mask

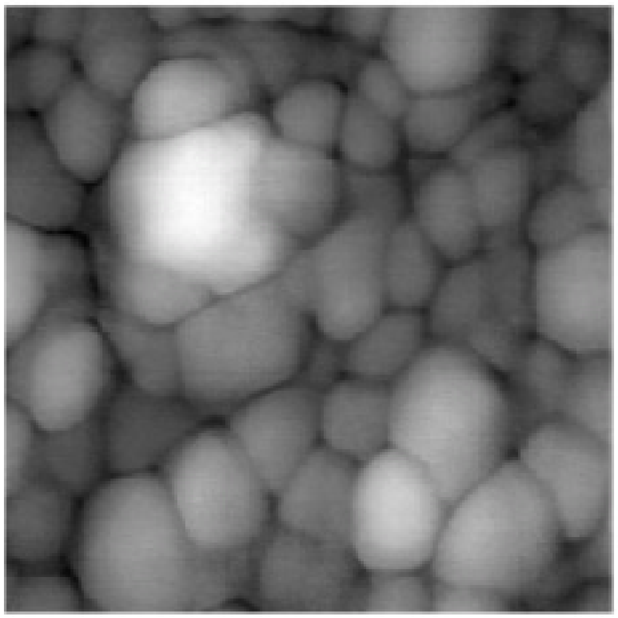
Convolution Masks **Vs** **Spatial masks**

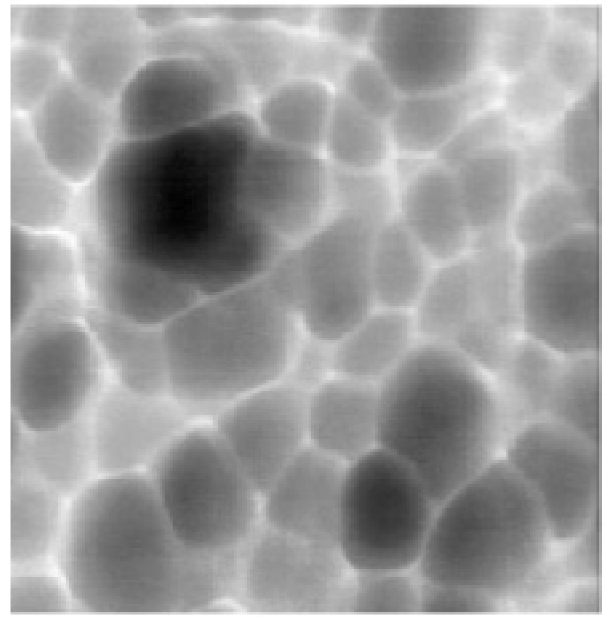
Convolution Masks → Involves flipping about origin

Spatial masks → No flipping

Gray level transformations

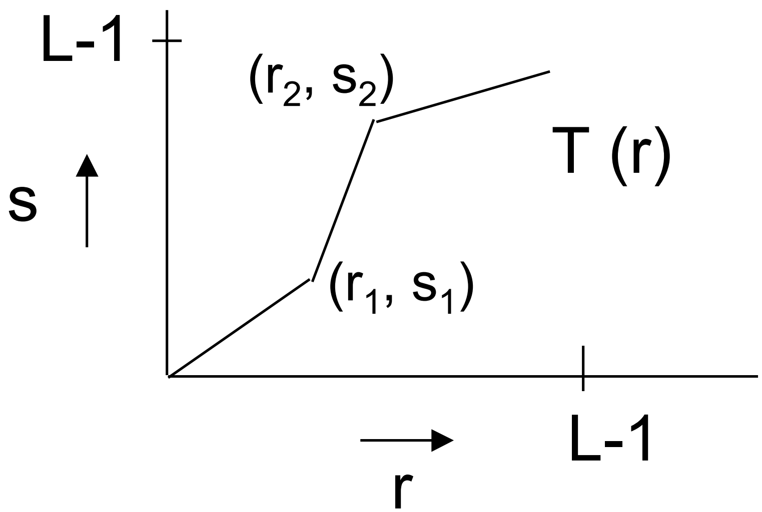
(a) Negative image: Example: $g(x,y) = 255 - f(x,y)$





Contrast Stretching

(b) Contrast stretching



$r_1 = s_1$
$r_2 = s_2$

no change

$r_1 = r_2$
$s_1 = 0$
$s_2 = L-1$

Thresholding at r_1

Log Transformation

(c) Compressing dynamic range

$$s = c \log(1 + |r|) \qquad c \longrightarrow \text{Scaling factor}$$

Example: Displaying the Fourier Spectrum

Power-Law Transformations

$$s = cr^{\gamma}$$

C and \gamma are positive constants.

Often referred to as “gamma correction”.

CRT –intensity-to-voltage response follows a power function (typical value of gamma in the range 1.5-2.5.)

Gamma correction

\gamma=1, 0.7, 04. 0.1

Gamma correction (cont.)

\gamma=1, 2, 5.

Figure 3.6

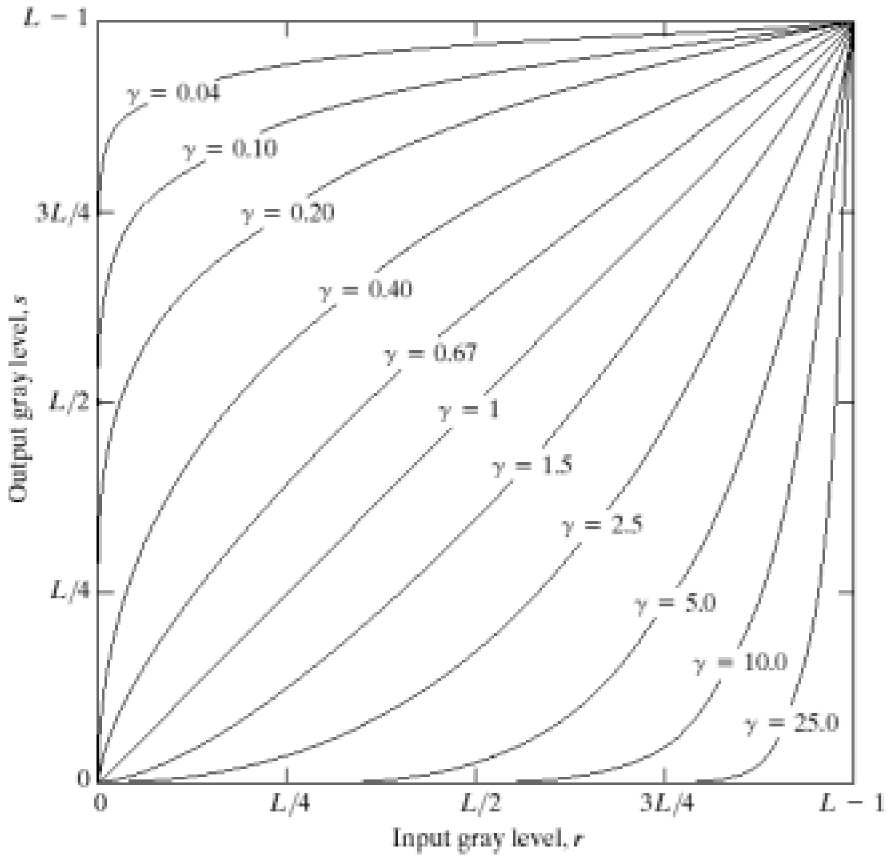


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases).

In Matlab

- Checkout the imadjust function.
  - Adjust image intensity values or colormap

Syntax

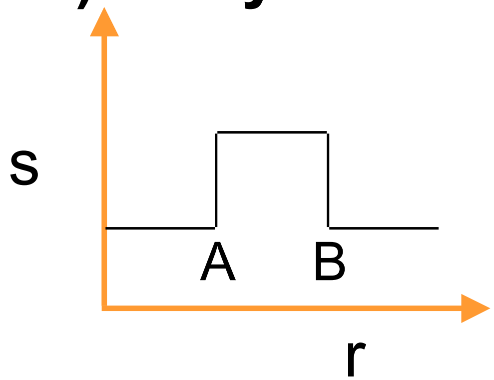
J = imadjust(I,[low_in high_in],[low_out high_out],gamma)

newmap = imadjust(map,[low_in high_in],[low_out high_out],gamma)

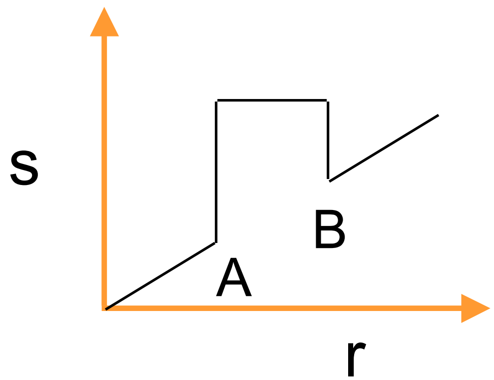
RGB2 = imadjust(RGB1,...)

Point Processing (contd.)

(d) Gray level slicing (Intensity level slicing)



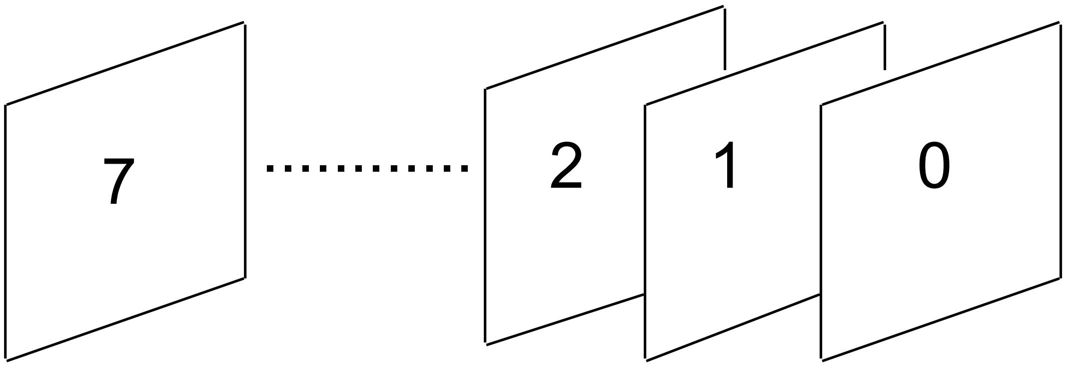
Highlights only the range [A - B]



Preserves other intensities

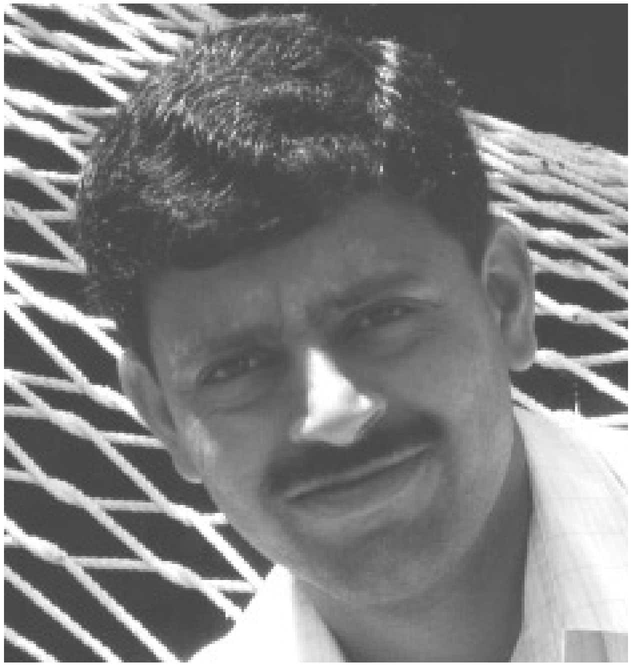
Bit plane slicing

(e) Bit plane slicing



Highlights contributions made by specific bits

MSB plane: an example



Threshold at 128

Figure 3.13: bit plane slicing

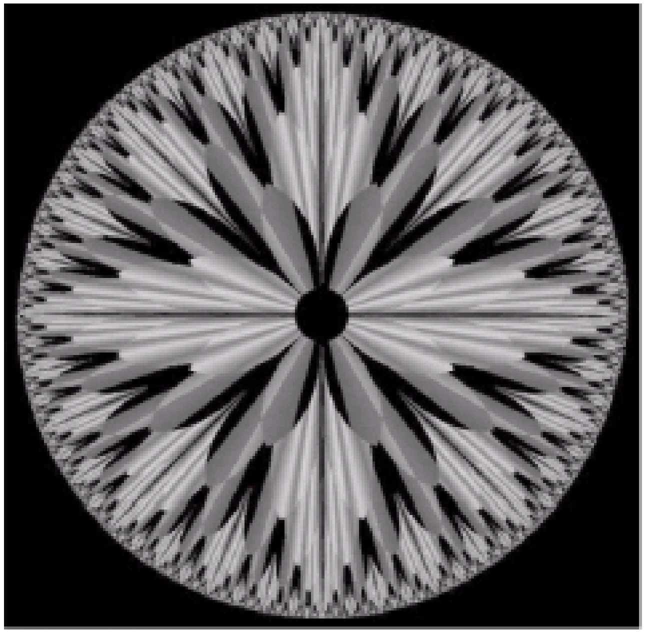


FIGURE 3.13 An 8-bit fractal image. (A fractal is an image generated from mathematical expressions). (Courtesy of Ms. Melissa D. Binde, Swarthmore College, Swarthmore, PA.)

Figure 3.14: bit planes

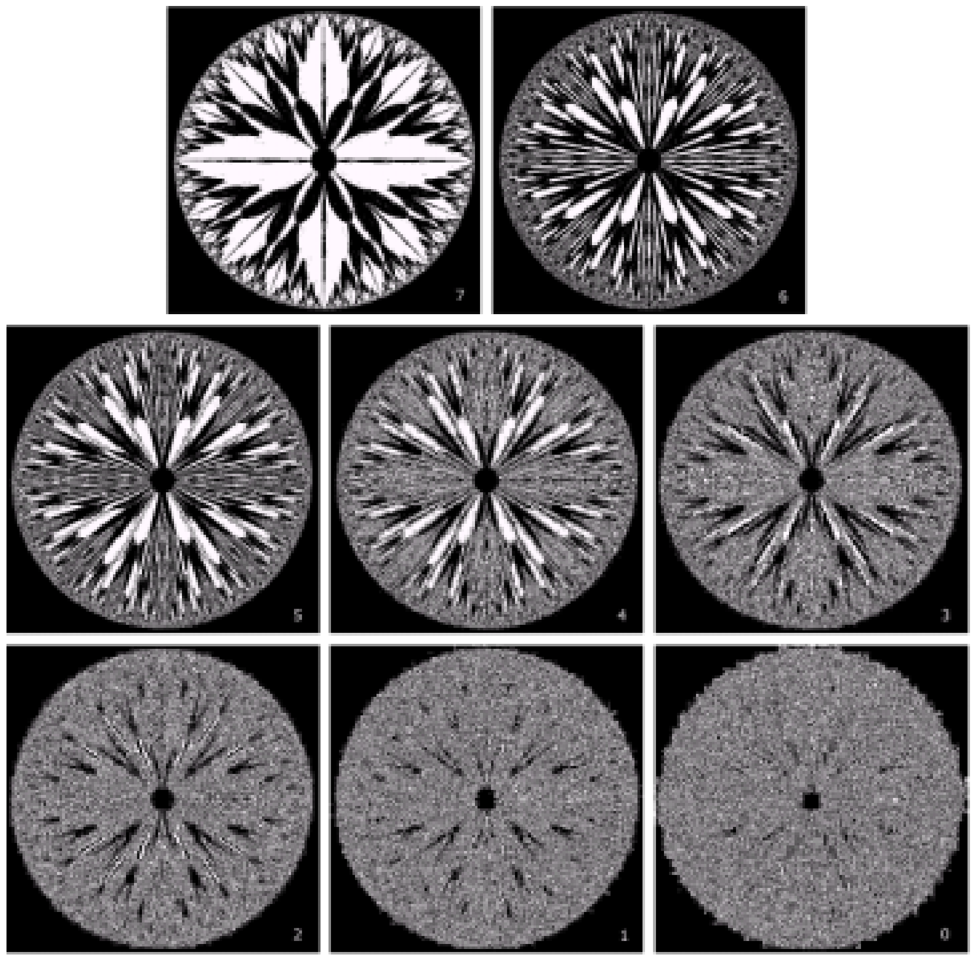


FIGURE 3.14 The eight bit planes of the image in Fig. 3.13. The number at the bottom, right of each image identifies the bit plane.