Image Operations
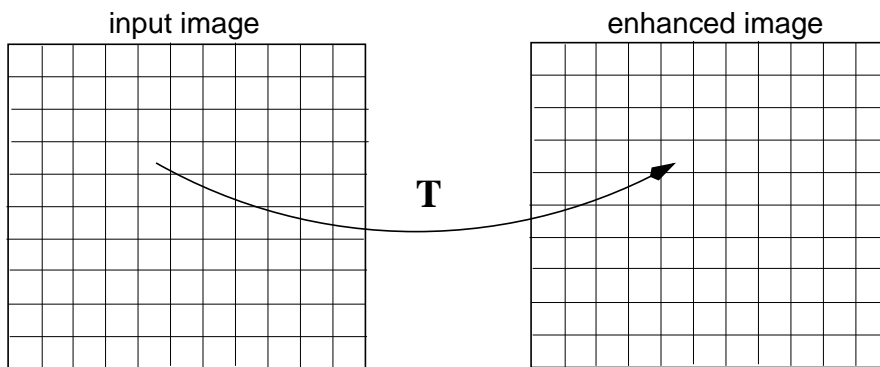
• Classification of Image Operations

- Spatial domain methods

      * Point Processing Tranformations
      * Area/Mask Processing Tranformations
      * Geometric Tranformations
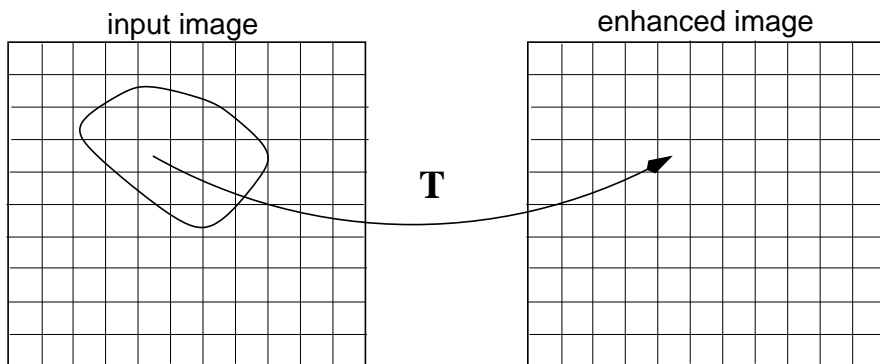   * Frame Processing Transformations

- Frequency domain methods

Point Processing Methods

input image   enhanced image

T

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

T operates on 1 pixel

Area or Mask Processing Methods

input image   enhanced image
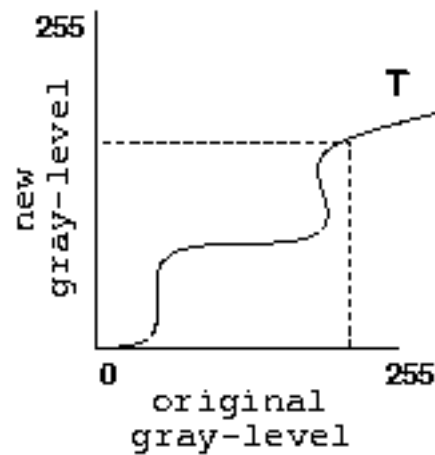
T

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

**T operates on a
neighborhood of pixels**

Point Processing Methods

- The most primitive, yet essential, image processing operations.

- Intensity transformations that convert an old pixel into a new pixel based on some predefined function.

- They operate on a pixel based solely on that pixel's value.
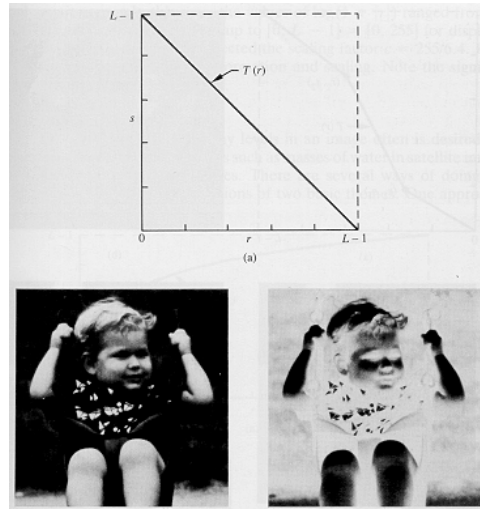
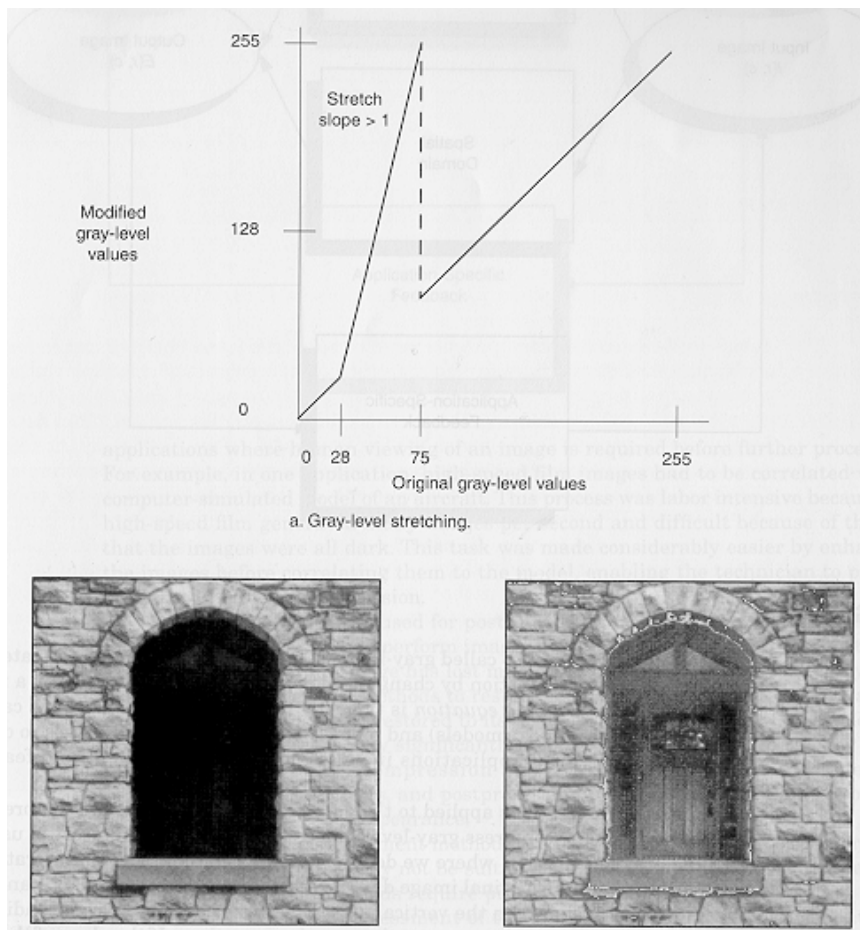- Used primarily for *contrast enhancement*.

• Identity Transformation

$$g(x,y) = f(x,y)$$
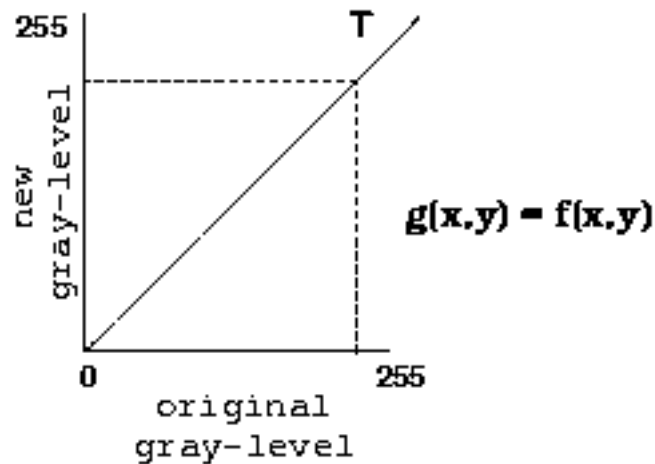
• Negative Transformation

$$O(r, c) = 255 - I(r, c)$$

• Contrast Stretching/Compression

- Stretch gray-level ranges where we desire more information.

a. Gray-level stretching.

• Intensity-Level Slicing

- Highlight a specific range of gray-levels only.

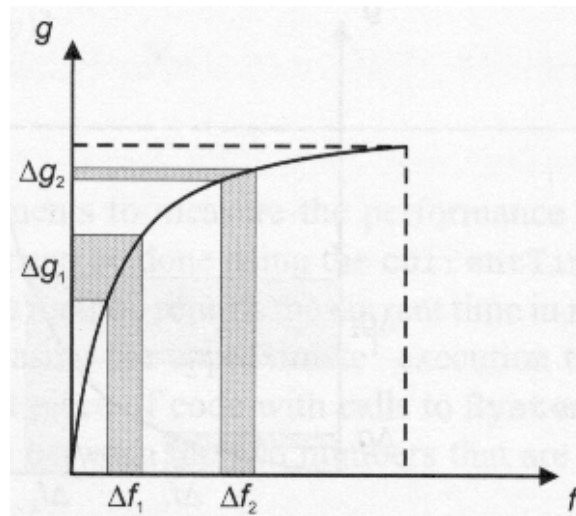a. This operation returns the original gray levels.

b. Original image.
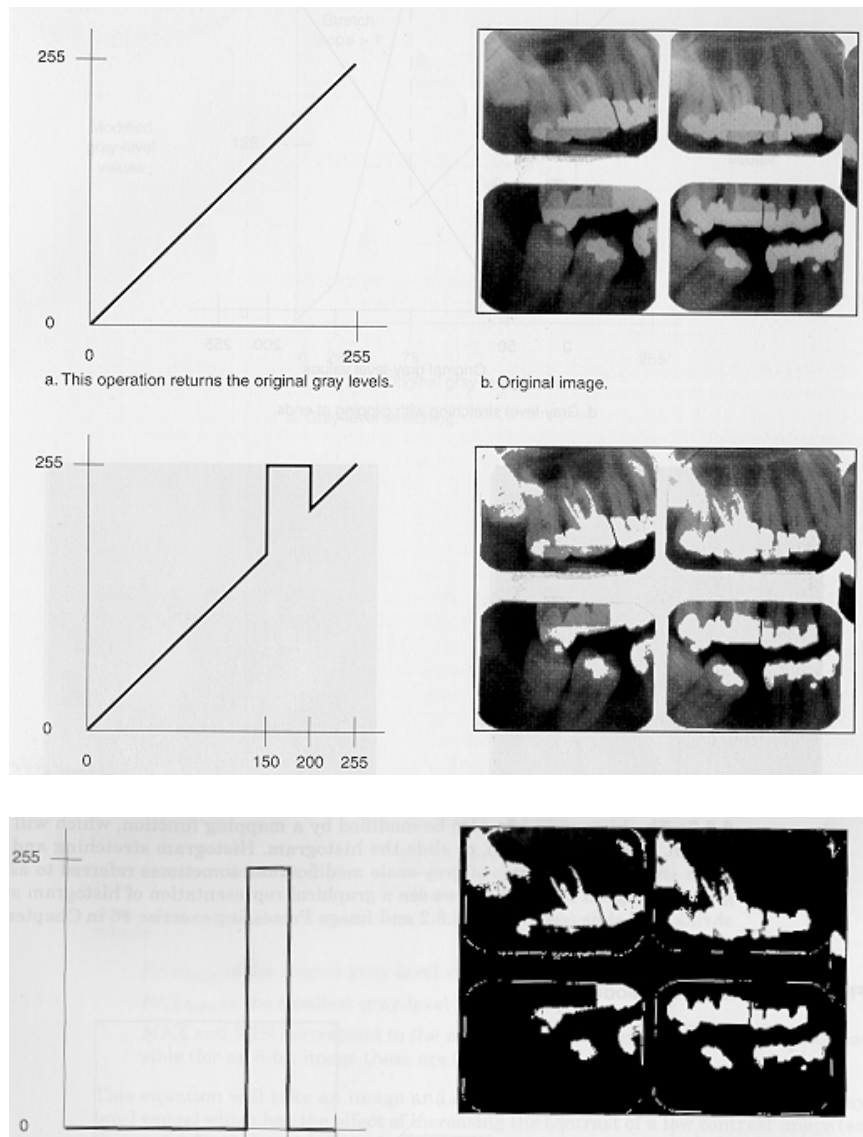
(same as double-thresholding)

• Non-linear Transformations

- We may use any function, provided that is gives a *one-to-one* or *many-to-one* (i.e., single-valued) mapping.
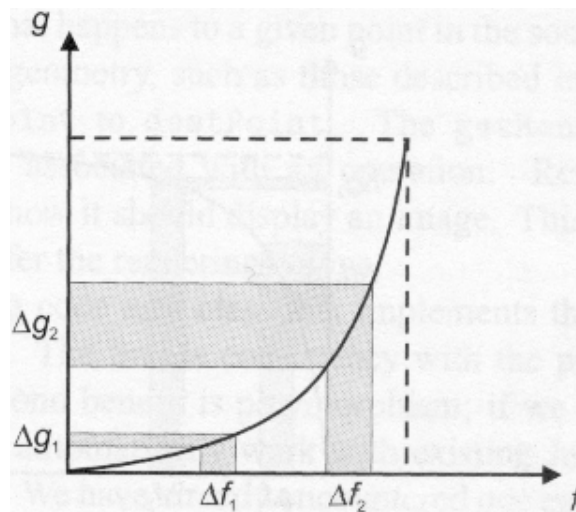
Logarithmic

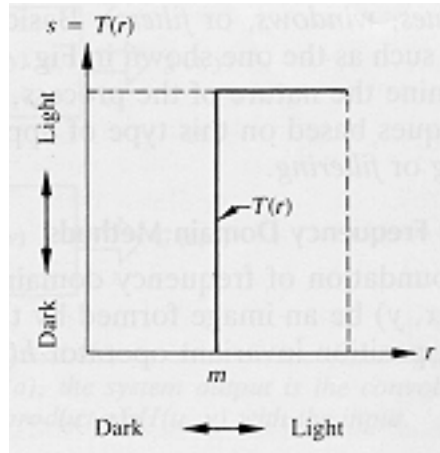- Useful for enhancing details in the darker regions of the image at the expense of detail in the brighter regions.

Exponential

- The effect is the reverse of that obtained with logarithmic mapping.

• **Thresholding**

• **Histogram Equalization**

- *Low contrast* images are usually mostly dark, mostly light, or mostly gray.

- *High contrast* images have large regions of dark and large regions of white (e.g., someone inside a room, stading in front of a window on a sunny day).

- *Good contrast* images exhibit a wide range of pixel values (i.e., no single gray level dominates the image).

0	0	1	0	2	0
1	0	7	7	7	0
0	7	0	0	7	0
1	0	0	7	2	0
0	0	7	1	0	1
1	0	7	7	7	0

frequencies

$f(0) = 18$

$f(1) = 6$

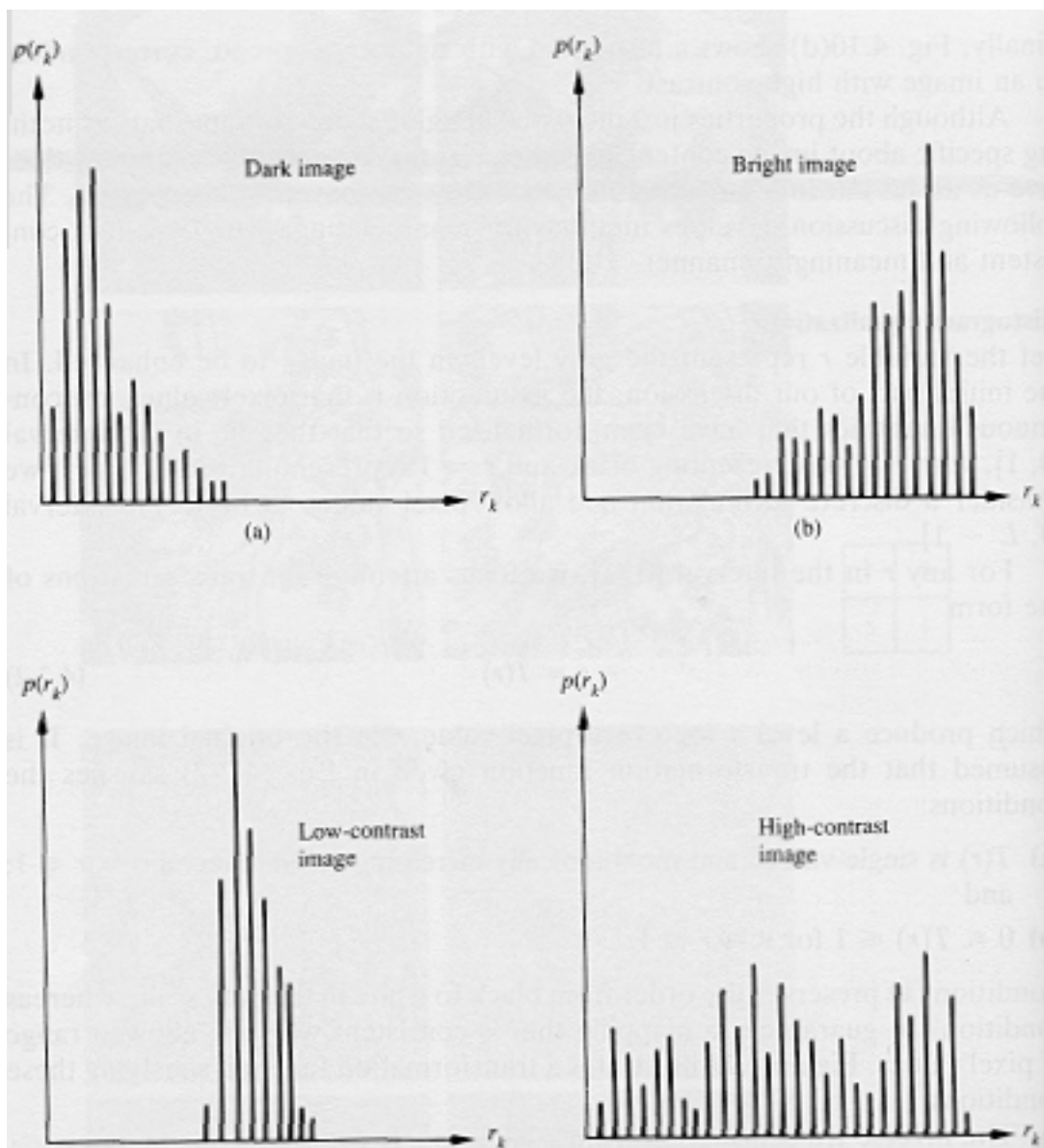$f(2) = 2$

$f(3) = f(4) = f(5) = f(6) = 0$

$f(7) = 10$
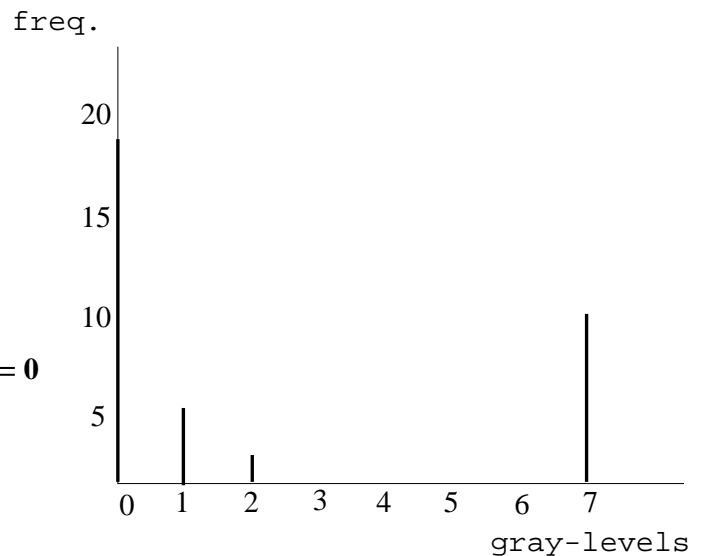
- The histogram of an image (i.e., a plot of the gray-level frequences) provides important information regarding the contrast of an image.

    * Histogram with a small spread: <u>low contrast image</u>
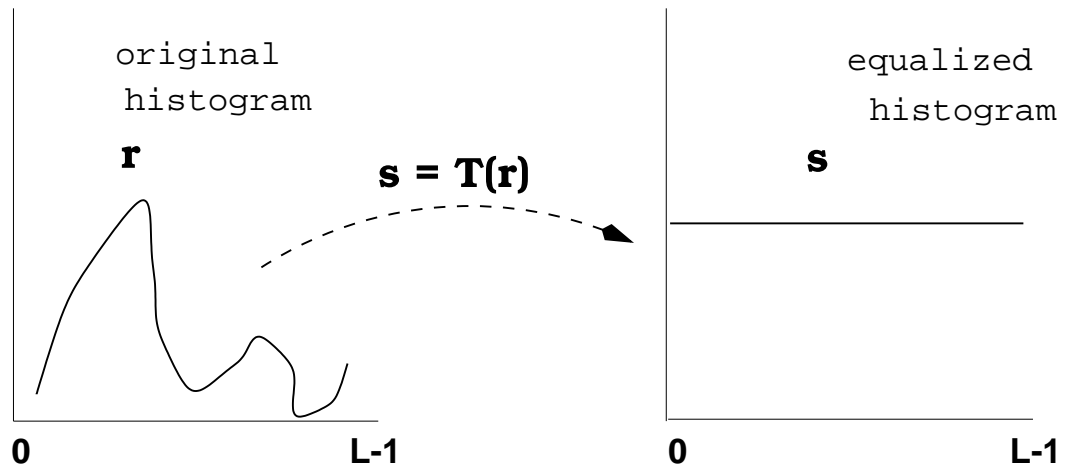
    * Histogram with wide spread: <u>high contrast image</u>

    * Histogram clustered at the low end: <u>dark image</u>

    * Histogram clustered at the high end: <u>bright image</u>

- Histogram equalization is a tranformation that stretches the contrast by redistributing the gray-level values uniformly.

- It is fully automatic compared to other contrast stretching techniques.

- In practice, the histogram might not become totally flat !