Image Processing

Lecture 4

Introducing Image Processing

Image Enhancement in the Spatial Domain

Background

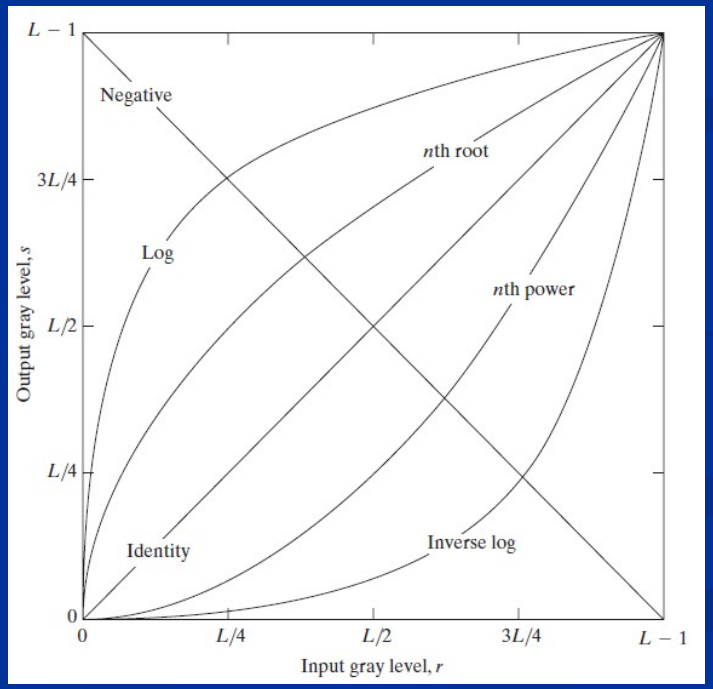
- The term *spatial domain* refers to the aggregate of pixels composing an image.
- Spatial domain methods are procedures that operate directly on these pixels. denoted by

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

- where f(x, y) is the input image, g(x, y) is the processed image, and T is an operator on f, defined over some neighborhood of (x, y).

Some Basic Gray Level Transformations

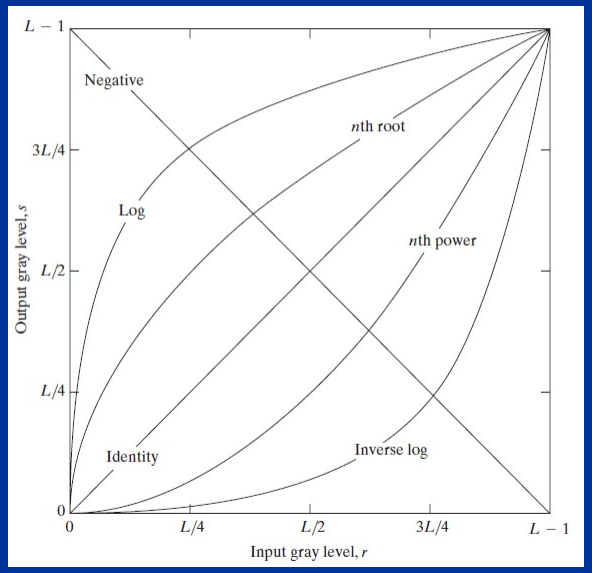
- **Image Negatives :** The negative of an image with gray levels in the range [0,L-1]is obtained by: $s = L - r - 1$

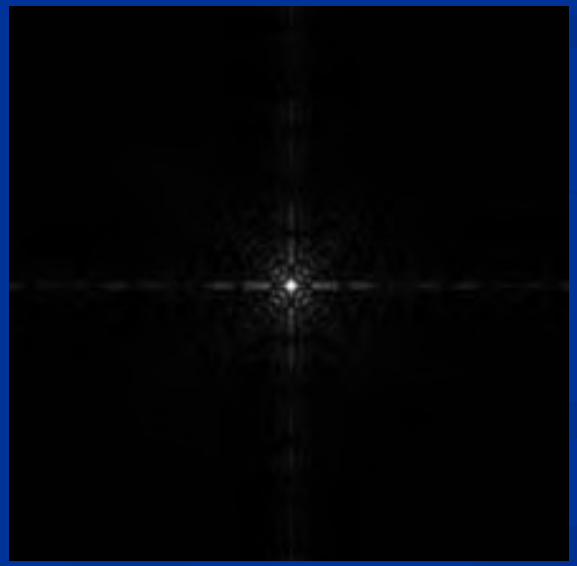


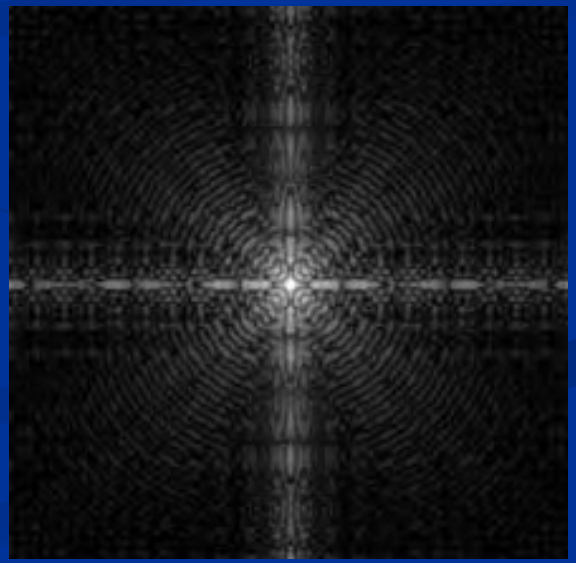
Some Basic Gray Level Transformations

- **Log Transformations :** maps a narrow range of low gray-level values in the input image into a wider range of output levels.

$$s = c \log (1 + r)$$

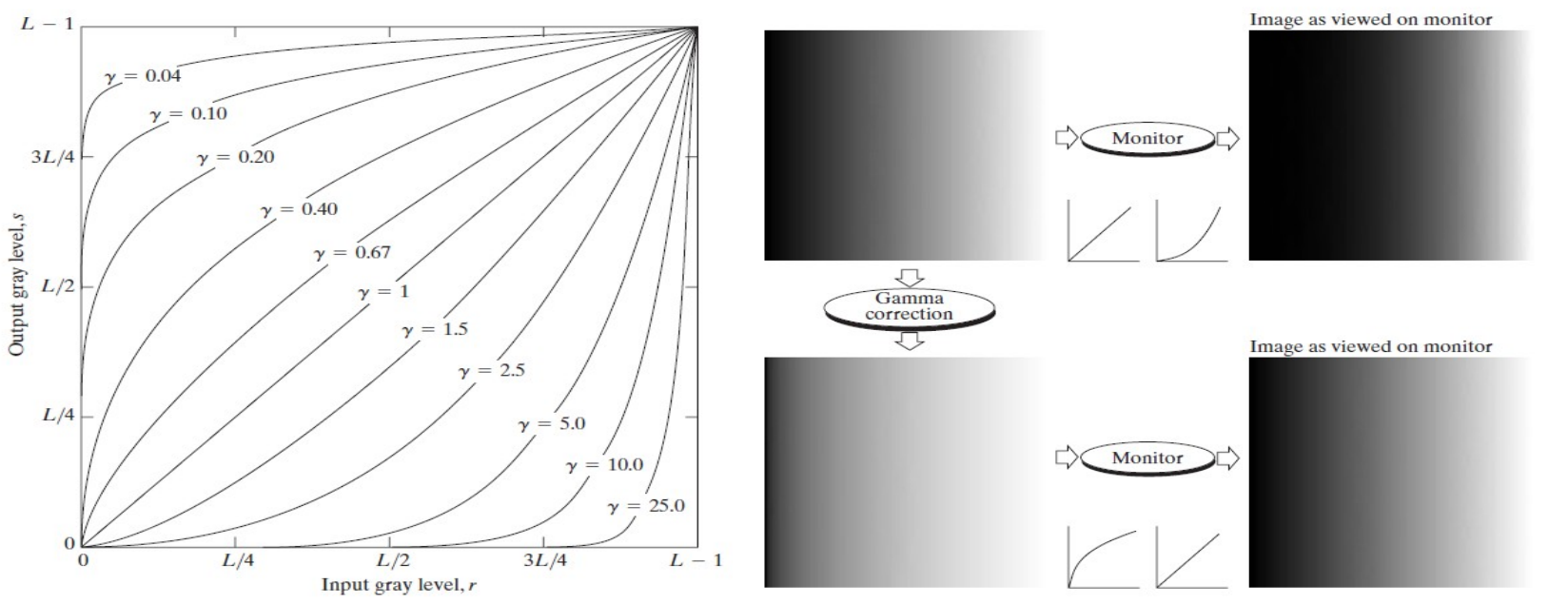






Some Basic Gray Level Transformations

- **Power-Law Transformations :** map a narrow range of dark input values into a wider range of output values. $s = cr^{\gamma}$ *gamma correction*



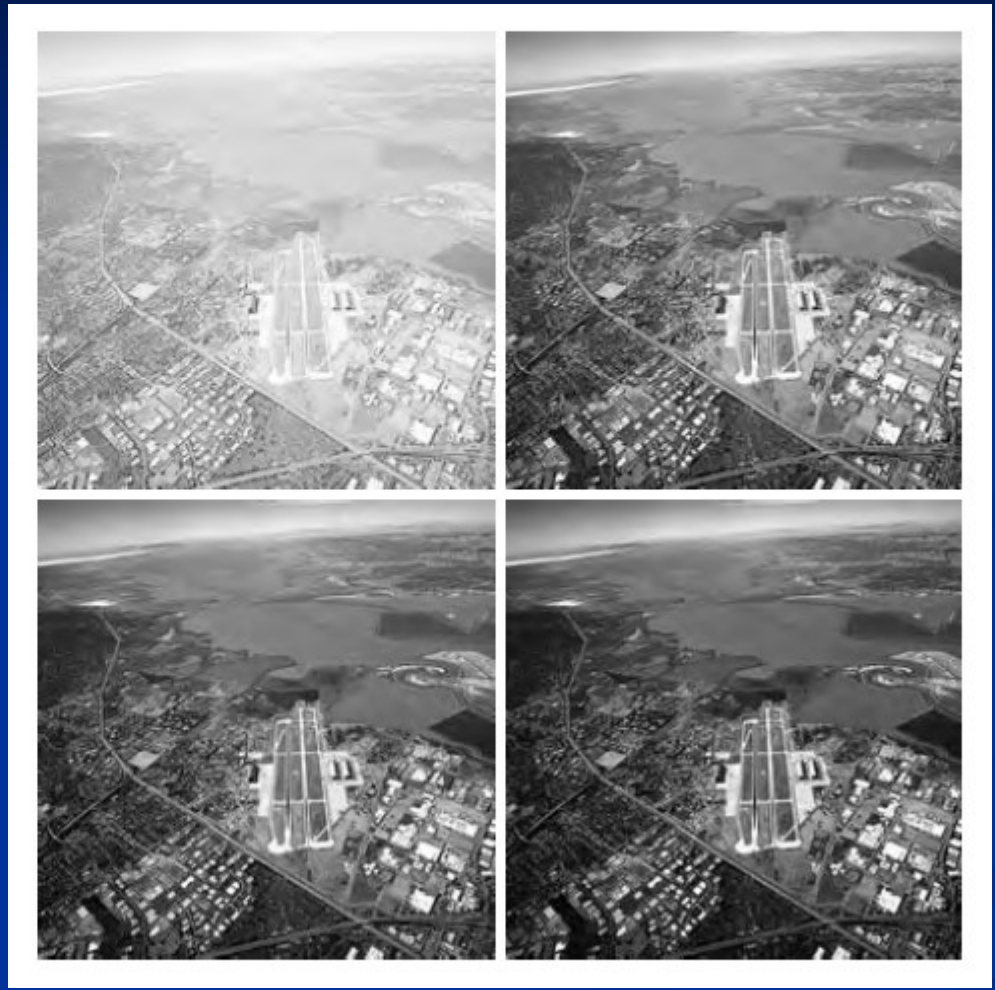
$$s = cr^{g}$$

$C = 1$

$g = 0.6$

0.4

0.3



$$s = cr^g$$

$C = 1$

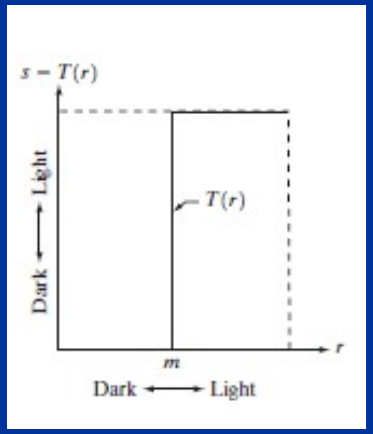
$g = 3.0$

4.0

5.0

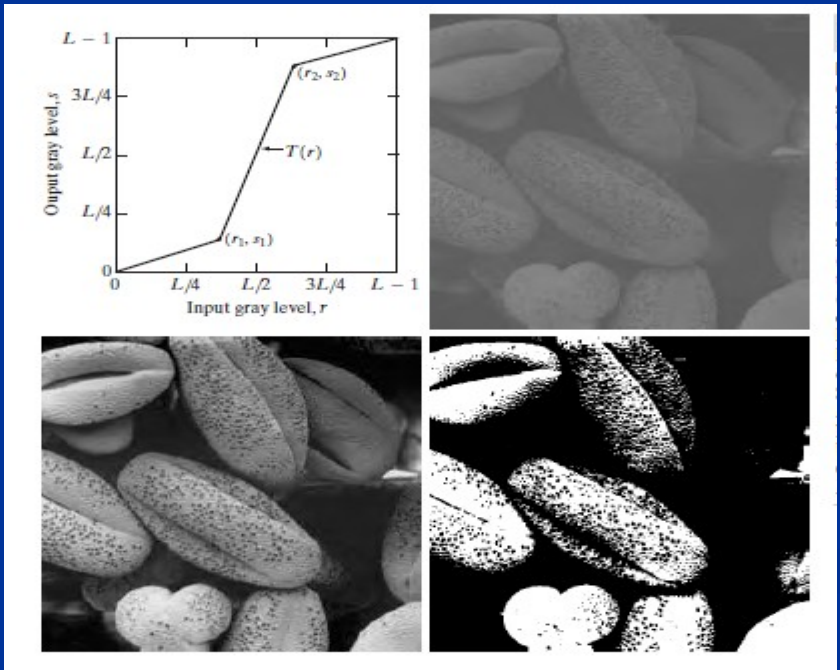
Piecewise-Linear Transformation Functions

- Thresholding : In this transformation, the pixels are categorized in a specific manner into categories and each category has its own gray level



Piecewise-Linear Transformation Functions

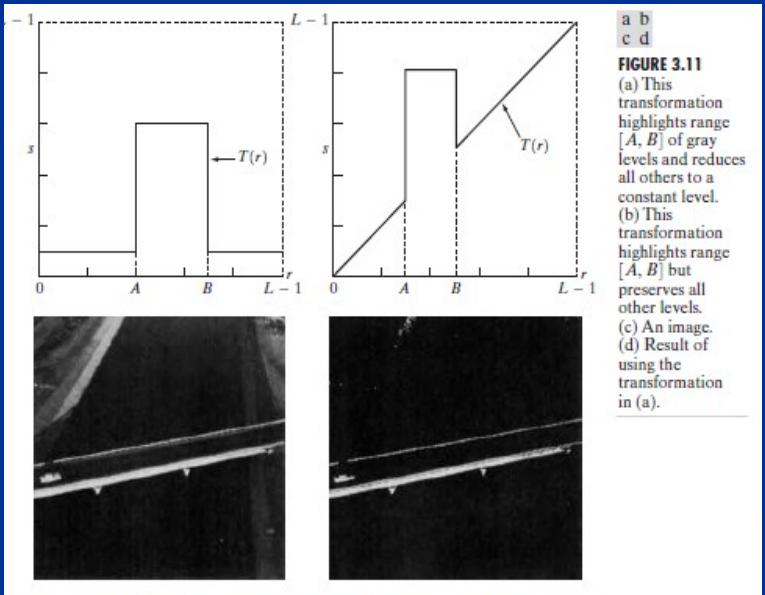
- **Contrast stretching :** The idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed



Intermediate values of r1, s1 and r2, s2 produce various degrees of spread in the gray levels of the output image, thus affecting its contrast

Piecewise-Linear Transformation Functions

- **Gray-level slicing: is a** Highlighting of a specific range of gray levels in an image and it often is desired for applications include enhancing features

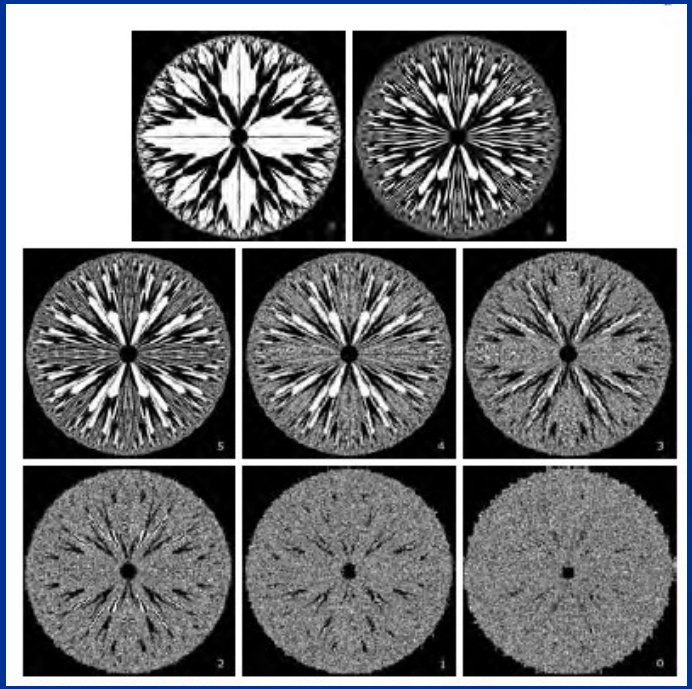


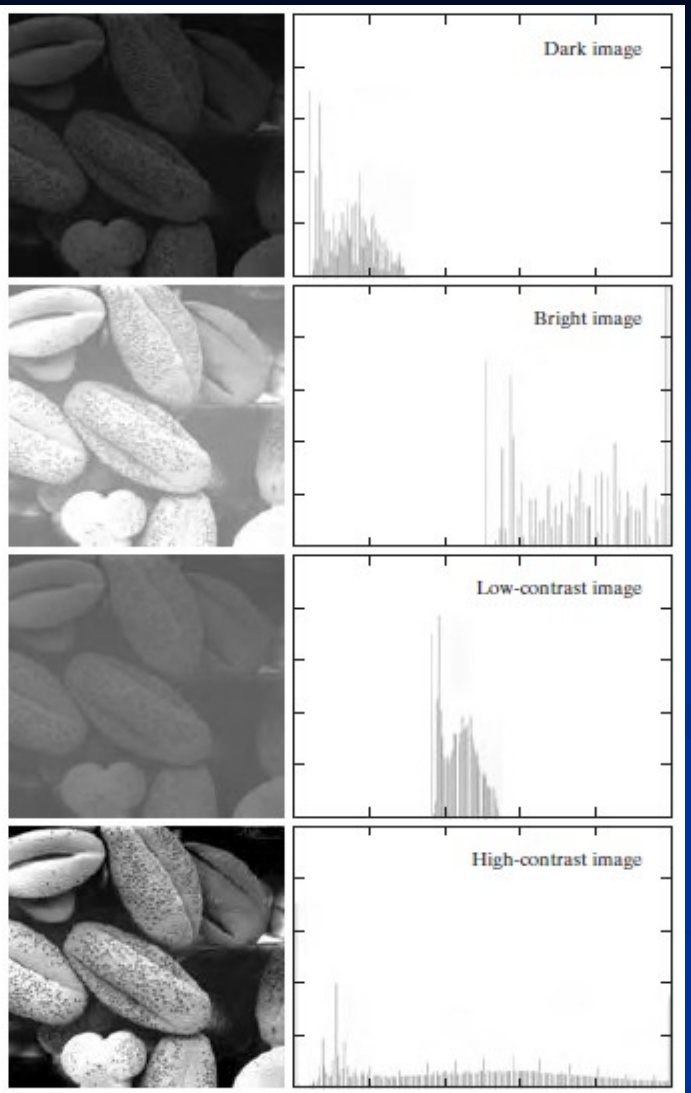
a b
c d

FIGURE 3.11
(a) This transformation highlights range $[A, B]$ of gray levels and reduces all others to a constant level. (b) This transformation highlights range $[A, B]$ but preserves all other levels. (c) An image. (d) Result of using the transformation in (a).

Piecewise-Linear Transformation Functions

- **Bit-plane slicing :** Instead of highlighting gray-level ranges, highlighting the contribution made to total image appearance by specific bits might be desired.




Dark image
Bright image
Low-contrast image
High-contrast image