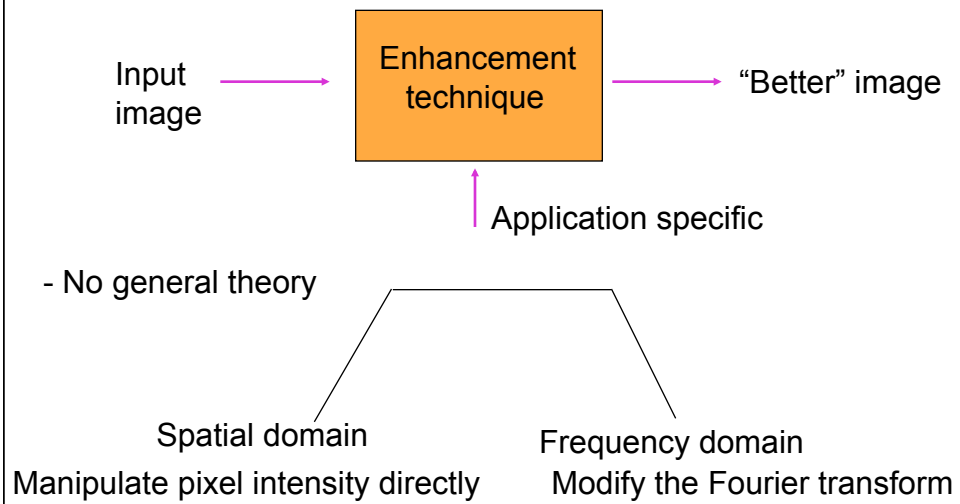


# Image Enhancement

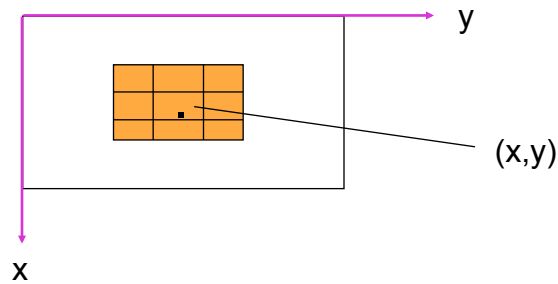
Reading:  
Chapter 3 (Spatial domain)

# Image Enhancement



## Spatial domain techniques

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



**Simplest case:** Neighbourhood is  $(x,y)$

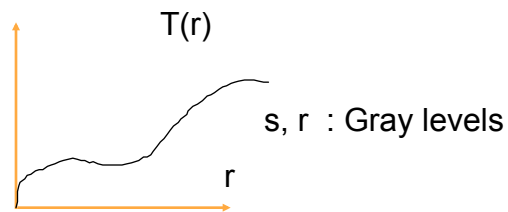
[  $g(\cdot)$  depends only on the value of  $f$  at  $(x,y)$  ]

## Contrast Stretching

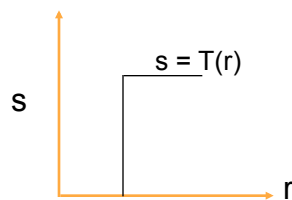
**Example:**

$$s = T(r)$$

$$s = T(r)$$



**Thresholding**

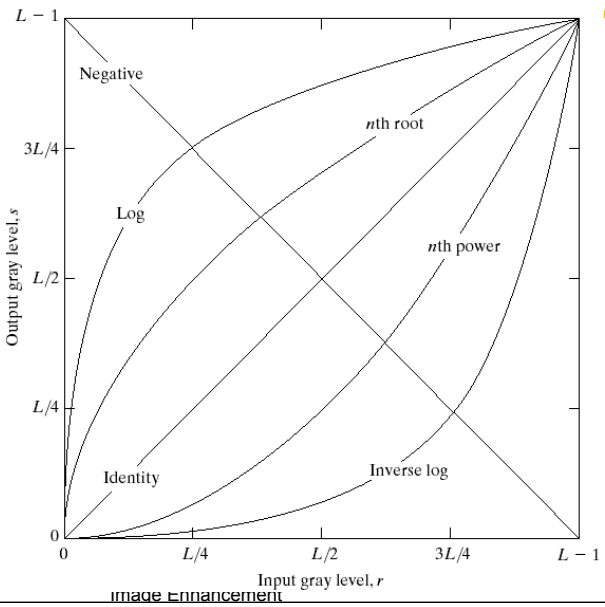


Example of contrast stretching.

There are all point operations  
hence referred to as point processing.

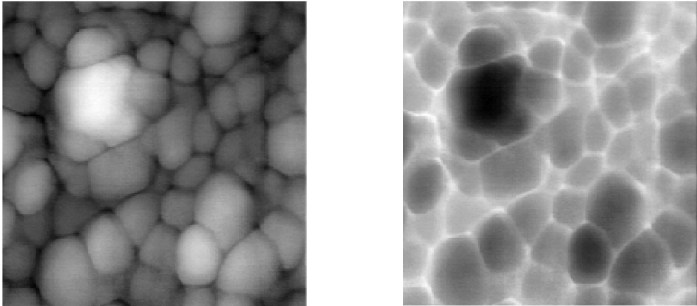
**Figure 3.3**

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

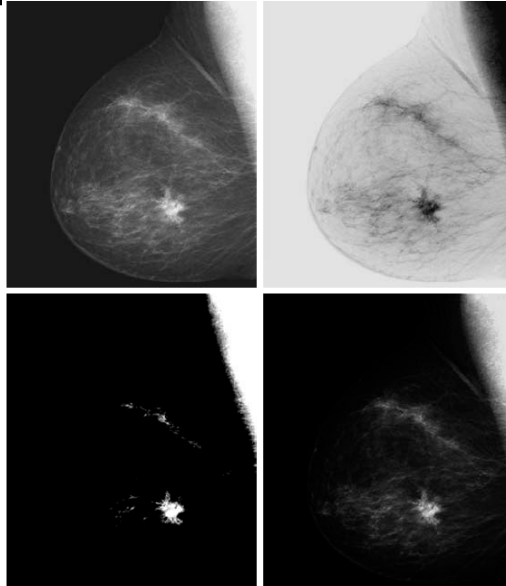


**Gray level transformations**

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



## Contrast Enhancement



a b  
c d

**FIGURE 3.3** (a) Original digital mammogram. (b) Negative image. (c) Result of expanding the intensity range [0.5, 0.75]. (d) Result of enhancing the image with gamma = 2. (Original image courtesy of G. E. Medical Systems.)

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## Log Transformation

(c) Compressing dynamic range

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

Example: Displaying the Fourier Spectrum

## Fourier spectrum

---

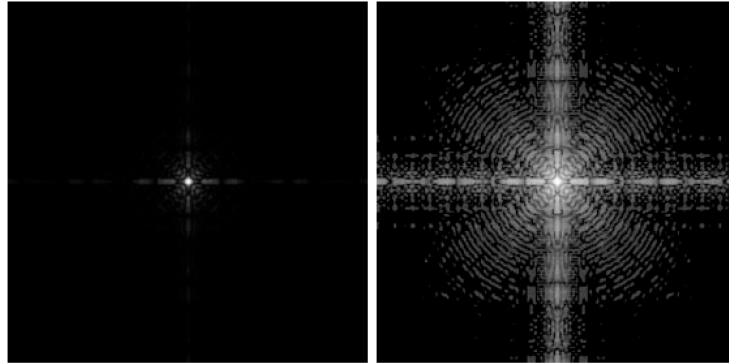


Fig 3.5: Log scaling

## Power-Law Transformations

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$$S = CR^\gamma$$

C and  $\gamma$  are positive constants.

Often referred to as “gamma correction”.

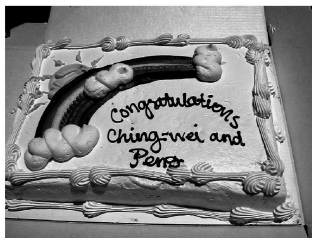
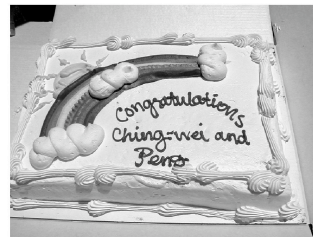
CRT –intensity-to-voltage response follows a power function (typical value of gamma in the range 1.5-2.5.)

## Gamma correction

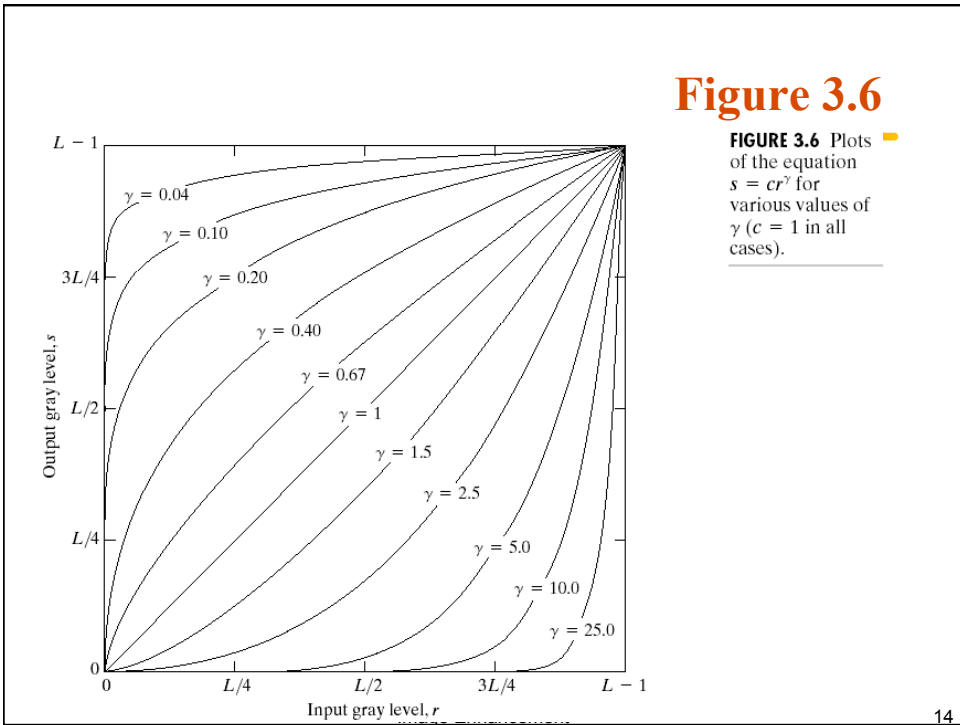
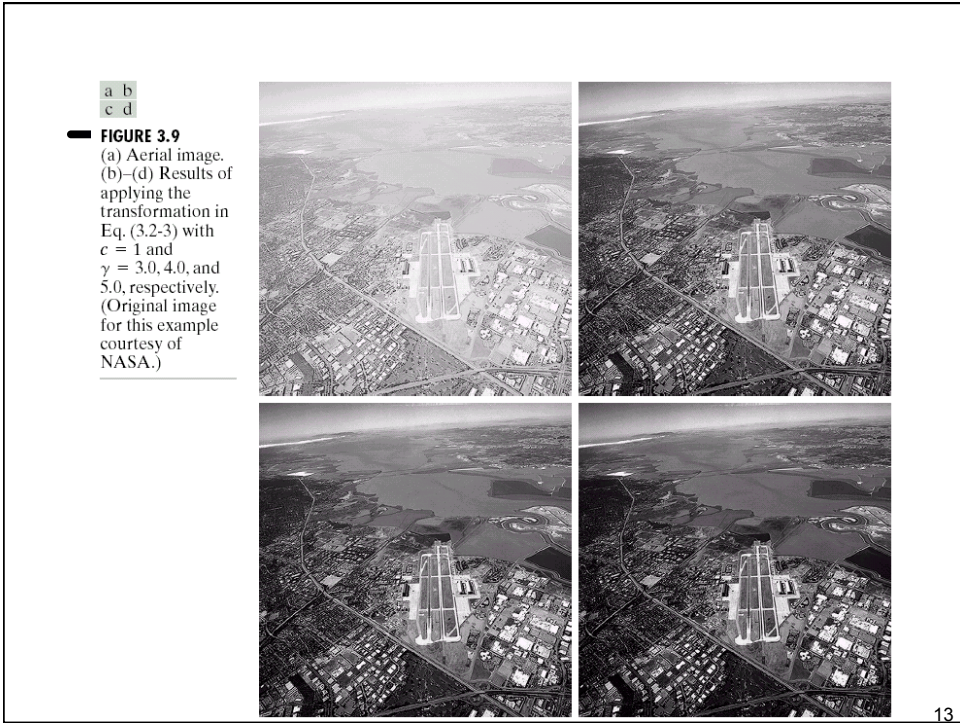


$\backslash\text{gamma}=1, 0.7, 0.1$

## Gamma correction (cont.)



$\backslash\text{gamma}=1, 2, 5.$



## In Matlab

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

### Syntax

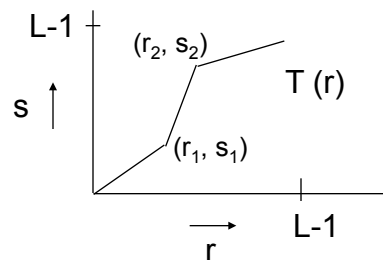
$J = \text{imadjust}(I, [\text{low\_in high\_in}], [\text{low\_out high\_out}], \text{gamma})$

$\text{newmap} = \text{imadjust}(\text{map}, [\text{low\_in high\_in}], [\text{low\_out high\_out}], \text{gamma})$

$\text{RGB2} = \text{imadjust}(\text{RGB1}, \dots)$

## Contrast Stretching

### (b) Contrast stretching



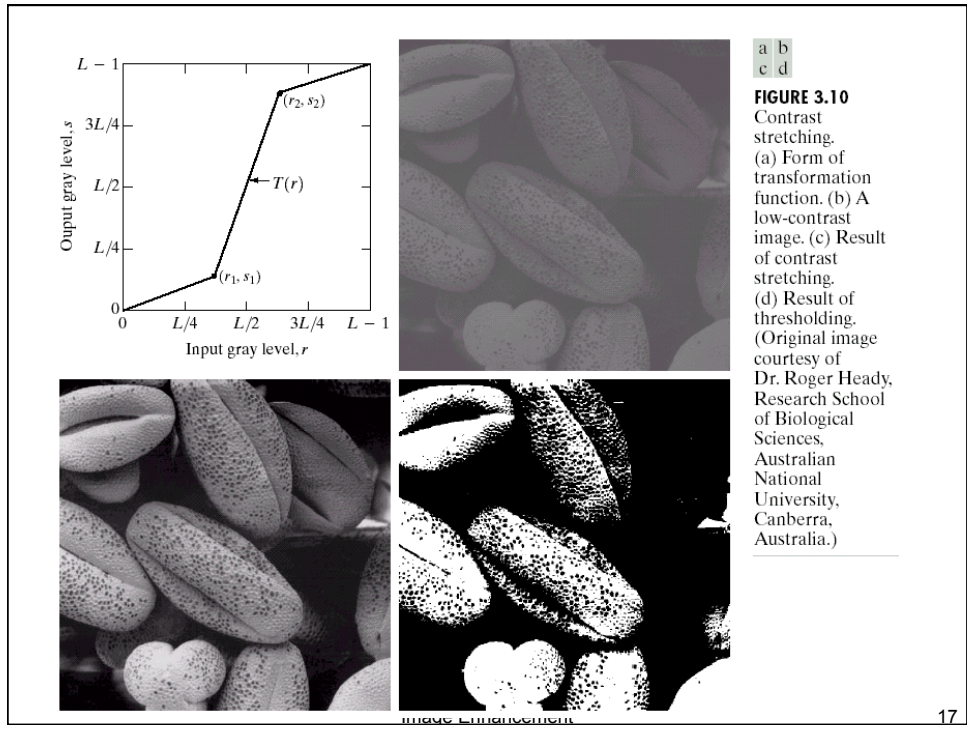
$$\begin{matrix} r_1 = s_1 \\ r_2 = s_2 \end{matrix}$$

no change

$$\begin{matrix} r_1 = r_2 \\ s_1 = 0 \\ s_2 = L-1 \end{matrix}$$

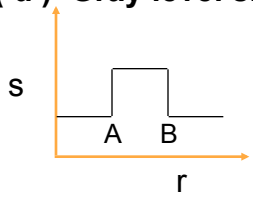
Thresholding  
at  $r_1$



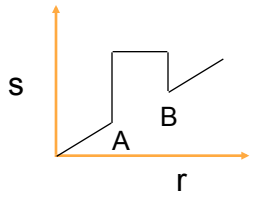


## Point Processing (contd.)

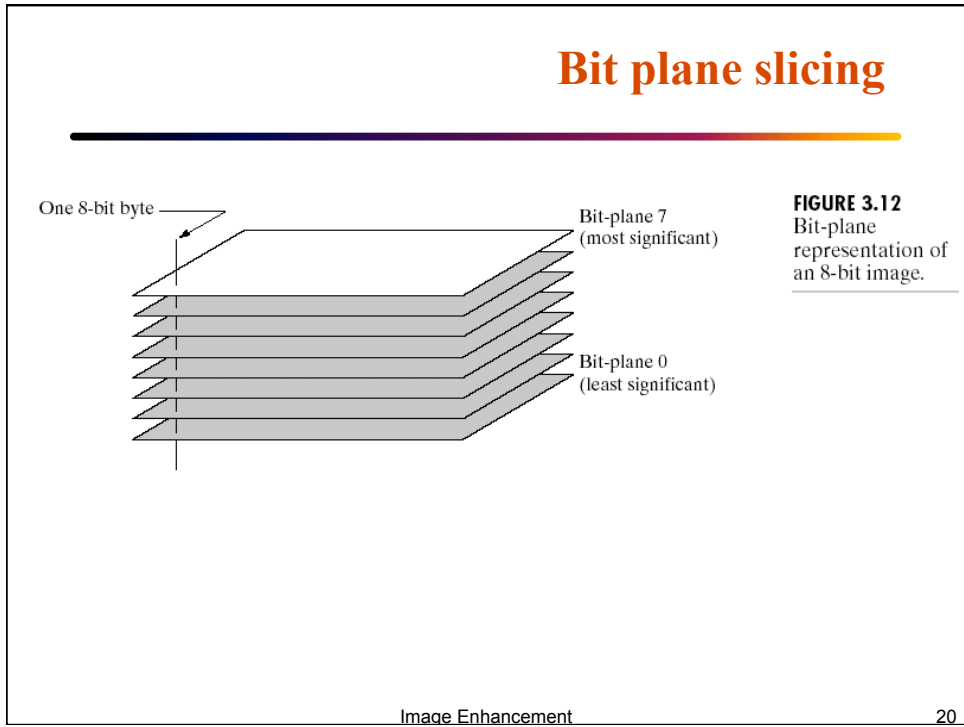
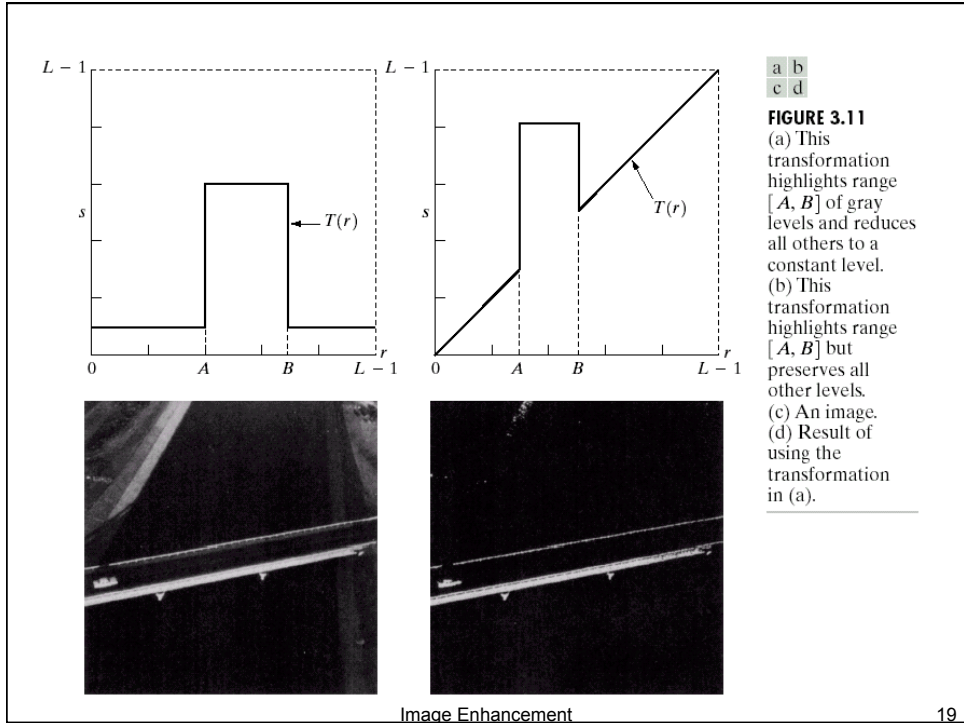
### (d) Gray level slicing ( Intensity level slicing)



Highlights only the range [ A - B ]

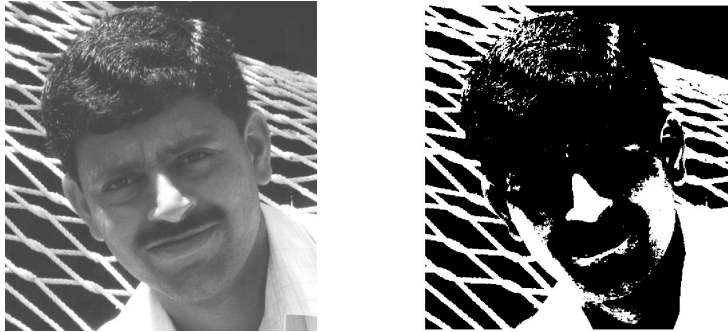


Preserves other intensities



## MSB plane: an example

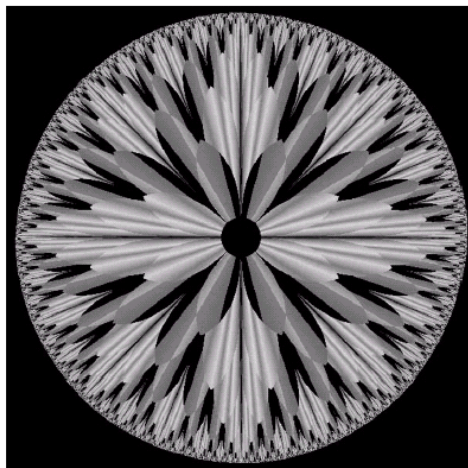
---



Threshold at 128

## Figure 3.13: bit plane slicing

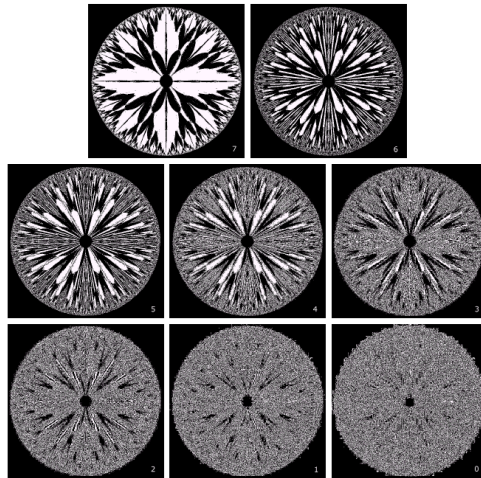
---



**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

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**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.