

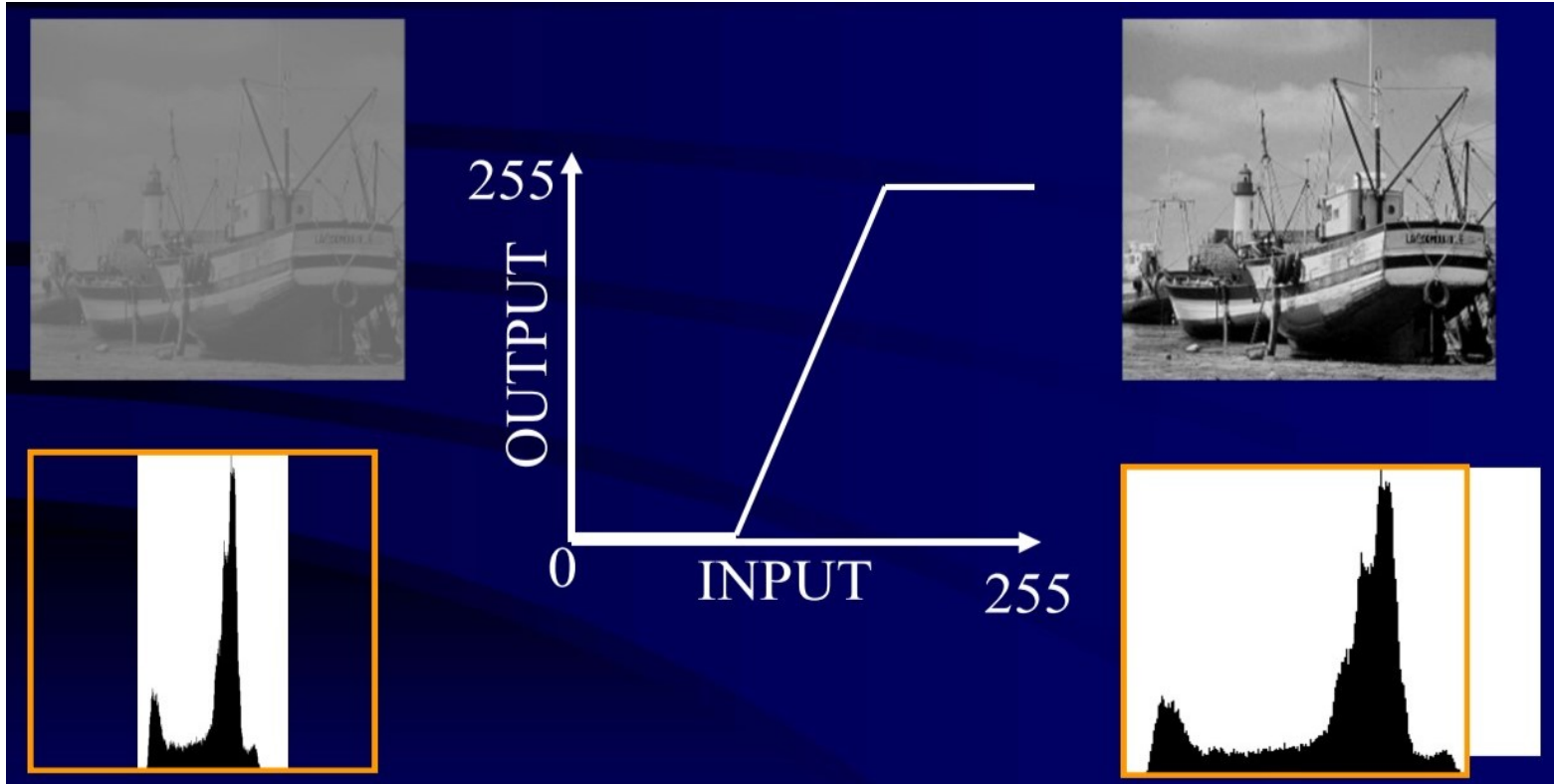
# Lecture 4 : Image & Processing

- Lecture 4 : Image & Processing
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## Point Operations

- A function is applied to **every pixel**: *Transfer function*  $O = T(I)$ .
- Operates only on the pixel's **current value**.
  - Thresholding
  - Color correction
  - Change Contrast: through the look up tables

## Contrast Change: Linear Stretching

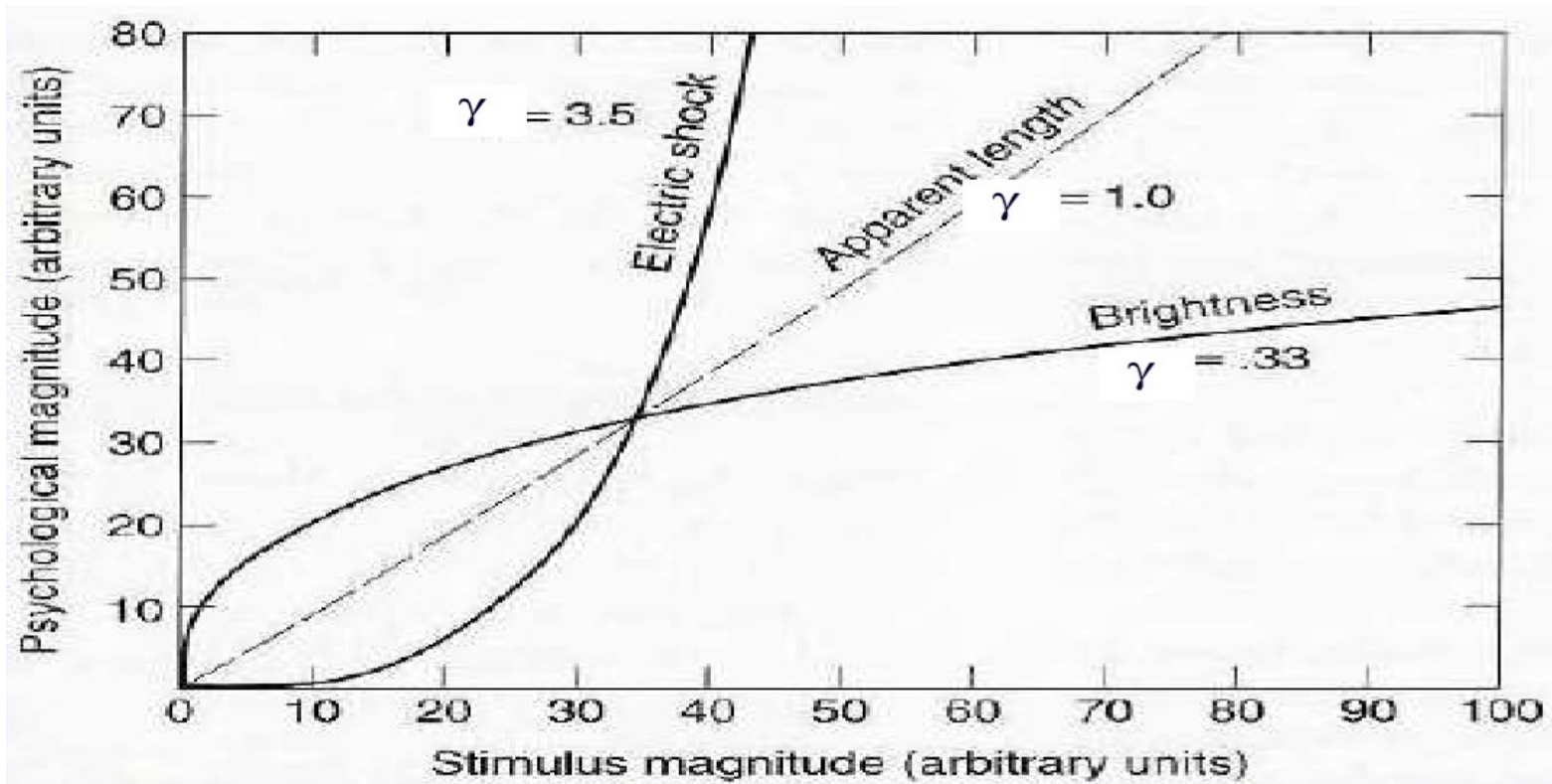


# Contrast Enhancement: Power Law Function

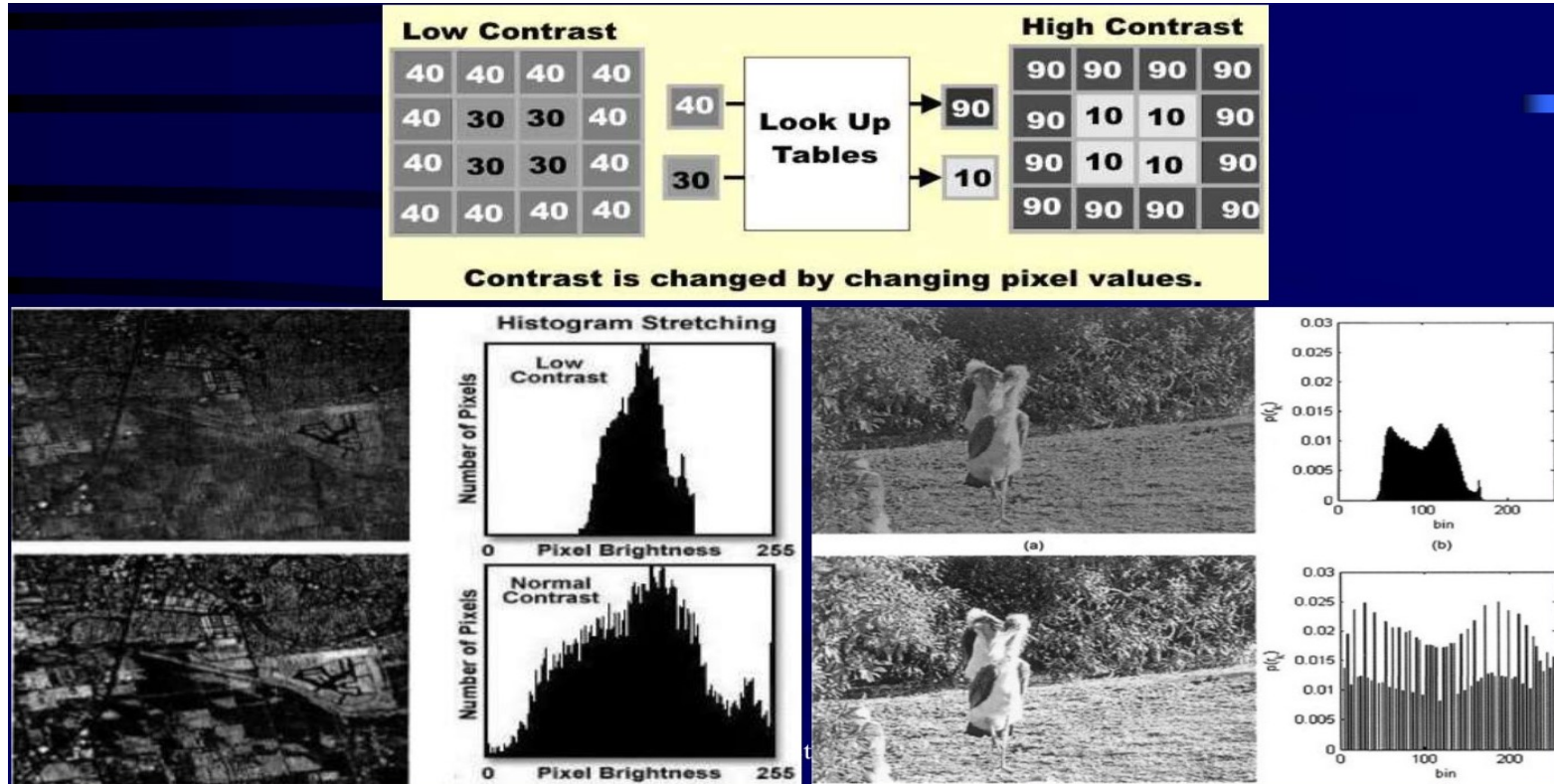
$$O = I^\gamma$$

$\gamma < 1$ : enhance **contrast** in the **dark** regions.

$\gamma > 1$ : enhance **contrast** in the **bright** regions.



# Contrast Enhancement: Look up tables (LUT)



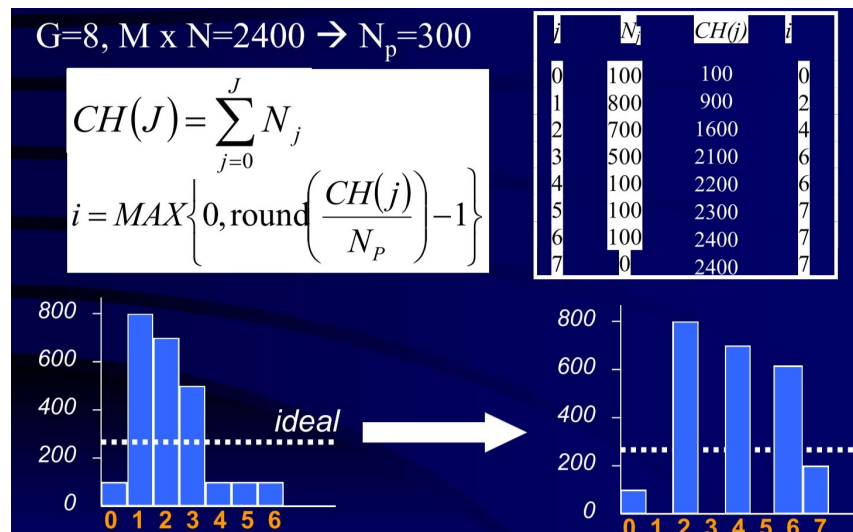
# Contrast Enhancement: Histogram Equalisation

- Expand Peak
- Squeeze Plain
- Objective: Flat histogram

$$N_P = \frac{M \times N}{G} \quad (M \times N: \text{no. of all pixels; } G: \text{no. of gray levels})$$

$$CH(J) = \sum_{j=0}^J N_j$$

$$i = \max \left( 0, \text{round} \left( \frac{CH(j)}{N_P} - 1 \right) \right) \quad (CH: \text{accumulated } N)$$



# Neighbourhood Operation

- Relationships between neighbours determine image features



## Convolution

- Mask: every pixel is a weight.
- Weights modify relationships between pixels.
- Convolution size =  $(M_1 - M_2 + 1) \text{ times } (N_1 - N_2 + 1)$

## Noise

Plot: image brightness.

## Noise Reduction: Low Pass Filter (1st principles)

$$C_{i+1} = \frac{A_i + A_{i+1} + A_{i+2}}{3}$$

## Noise Reduction: Low Pass Filter

Averaging: Smooth an image

With a convolution:

E.g.

$$\frac{1}{9} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

Problem: *blurs* the edge.

## Noise Reduction: Median Filter

$$C_i = \mathit{median} A_{i-1} \times B_1, A_i \times B_2, A_{i+1} \times B_3$$

## Filter Operations

1. Low-Pass Filter: smooth an image.

$$\frac{1}{9} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

2. High-Pass Filter: sharpen an image.

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

3. Sobel Edge Enhancement: Edge extraction (vertical mask & horizontal mask)

$$\begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$$

4. Laplacian Edge Enhancement

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$