# Enhancement in Digital Image Processing

Ashok N Shinde
ashok.shinde0349@gmail.com
International Institute of Information Technology
Hinjawadi Pune

September 7, 2017

# Image Enhancement in the Spatial Domain

The spatial domain

- The image plane
  - Digital image is a Cartesian coordinate system of discrete rows and columns.
  - At the intersection of each row and column is a pixel.
  - Each pixel has a value, which we will call intensity.
- The frequency domain
  - A (2-dimensional) discrete Fourier transform of the spatial domain image.
- Enhancement
  - To improve the quality of an image by using transformation on the image.
  - Often the improvement is to make the image better looking, by increasing the intensity or contrast.

# Image Enhancement in the Spatial Domain

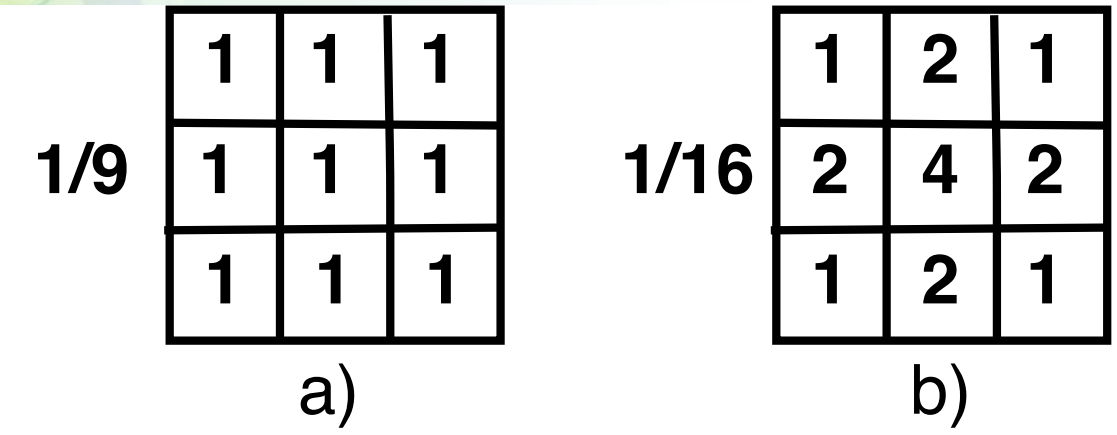
A mathematical representation of spatial domain enhancement

- The transformation is: $g(x, y) = T[f(x, y)]$
  - where $f(x, y)$ the input image.
  - where $g(x, y)$ the processed image.
  - $T$ : an operator on $f$, defined over some neighborhood of $(x, y)$
  - Example: Low Pass and High Pass Filtering
- Example: Low Pass Filtering
  - Low pass filter is used to remove high frequency content and noise
- Example: High Pass Filtering
  - High pass filter is used to remove low frequency content and obtain the edges in am image.

# Image Enhancement: Low Pass Filtering

Low Pass Filtering

- Example:




  - Filter a) is Low Pass Filter
  - Filter b) is Weighted Low Pass Filter
- Results:
- Remove the Noise from image.
- Blur the image.
- Generally used in Pre-processing.

# Image Enhancement: High Pass Filtering

## High Pass Filtering

- Example:

| | | |
|---|---|---|
| 1 | 1 | 1 |
| 0 | 0 | 0 |
| -1 | -1 | -1 |

a)

| | | |
|---|---|---|
| 1 | 0 | -1 |
| 1 | 0 | -1 |
| 1 | 0 | -1 |

b)

| | | |
|---|---|---|
| 0 | -1 | 0 |
| -1 | 4 | -1 |
| 0 | -1 | 0 |

c)

  - Filter a) Finds Vertical Edges
  - Filter b) Finds Horizontal Edges
  - Filter c) Laplacian - Point Detection
- Results:
- Finds the edges from image.
- Finds the horizontal and vertical edges.
- Generally used for Finding Shapes.

# Result: Low Pass and High Pass Filtering

Result of LPF and HPF

- Lena image filtered using Low Pass and High Pass Filter


- Lena image
- Lena image filtered using Low Pass
- Lena image filtered using High Pass Filter

# Other Image Enhancement Techniques

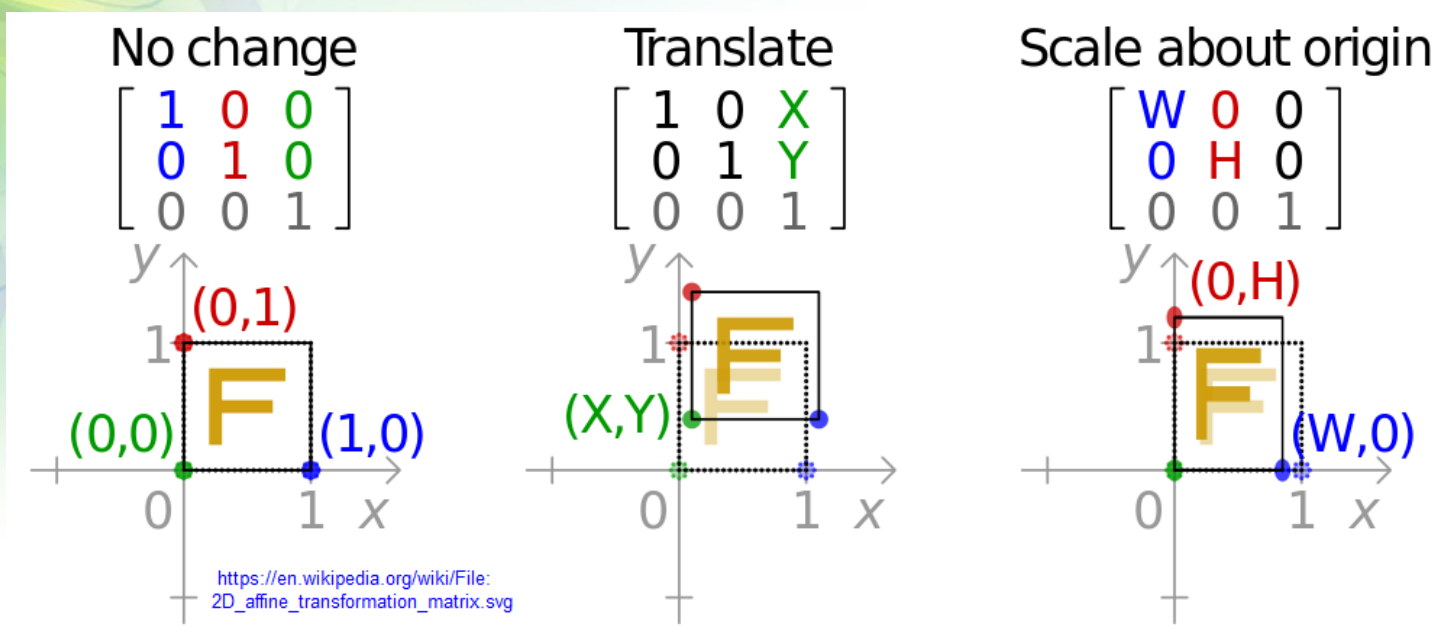
A mathematical representation of spatial domain enhancement

- Geometric transformation techniques
  - Image Reflection
  - Image Translation
  - Image Scaling
  - Image Shearing
- Spatial domain techniques
  - Point operations
  - Histogram equalization and matching
  - Applications of histogram-based enhancement
- Frequency domain techniques
  - Unsharp masking
  - Homomorphic filtering

# Geometric transformation techniques: Example

Geometric transformation

- Example:

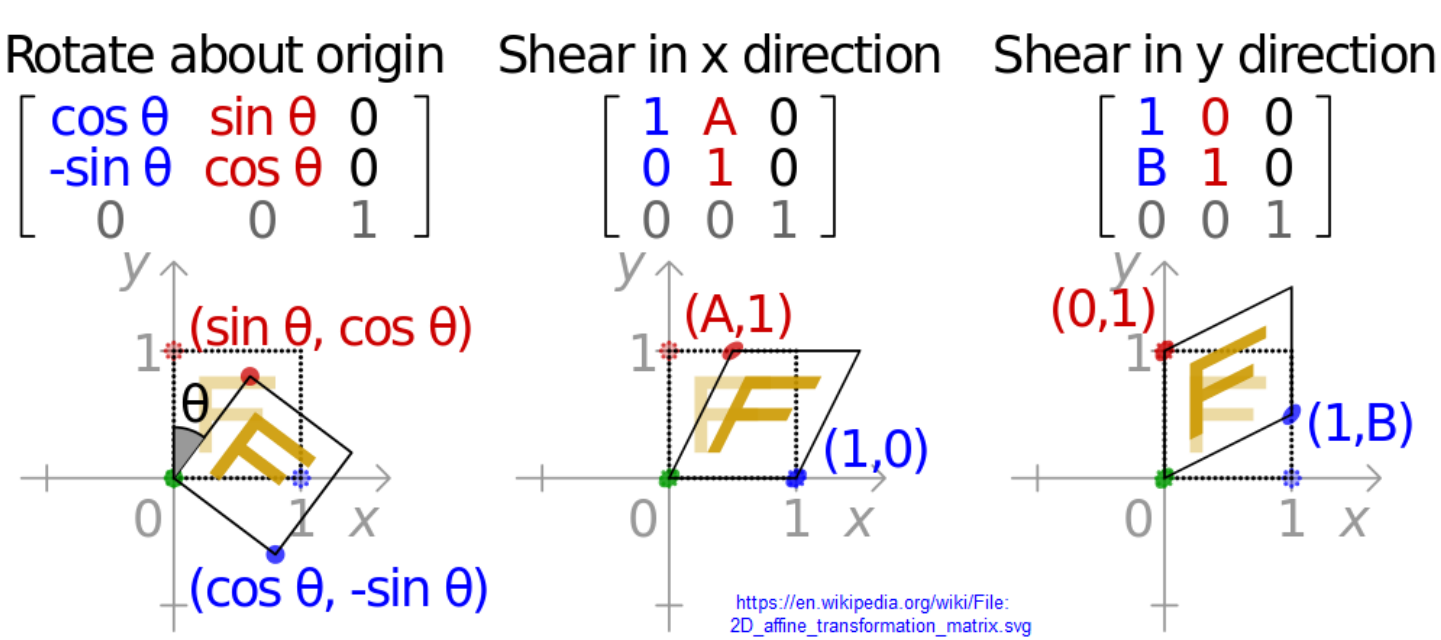



- No change
- Translation
- Scaling about origin

# Geometric transformation techniques: Example

Geometric transformation

- Example:

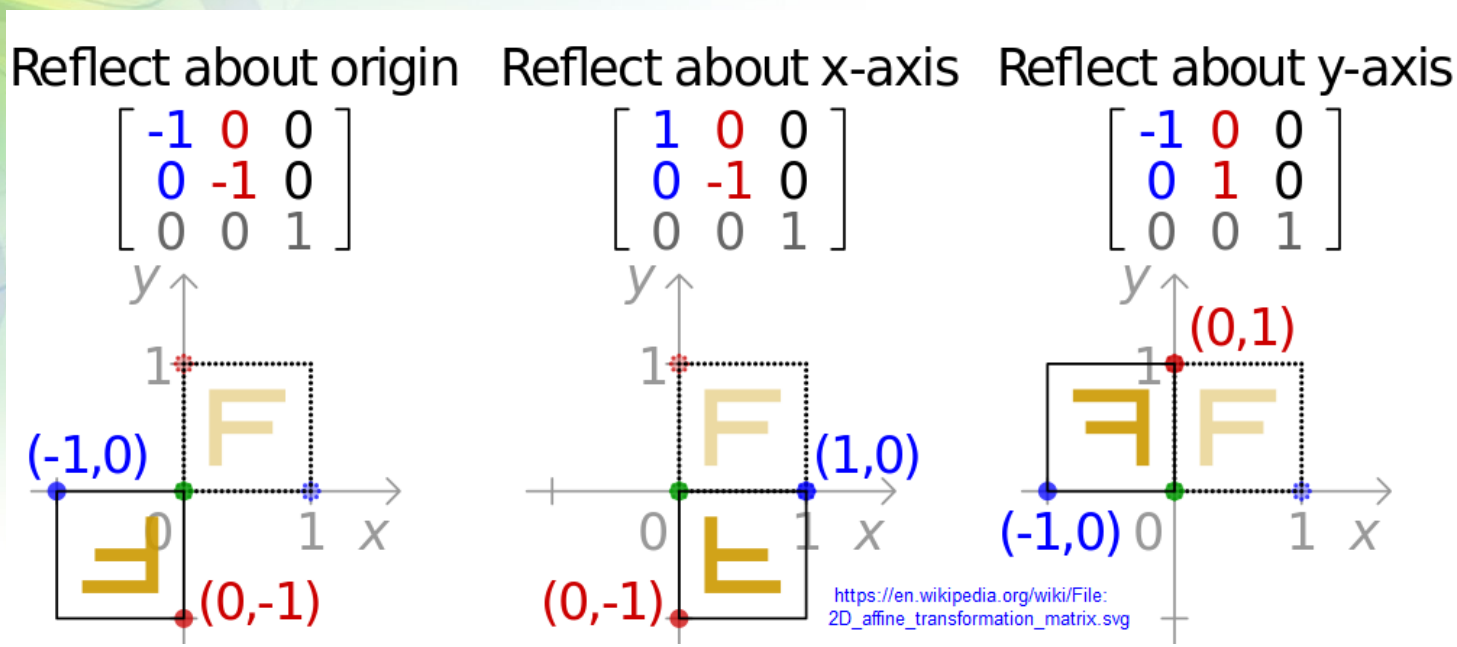



- Rotation about origin
- Shearing in x direction
- Shearing in y direction

# Geometric transformation techniques: Example

Geometric transformation

- Example:




- Reflection about origin
- Reflection about x axis
- Reflection about y axis

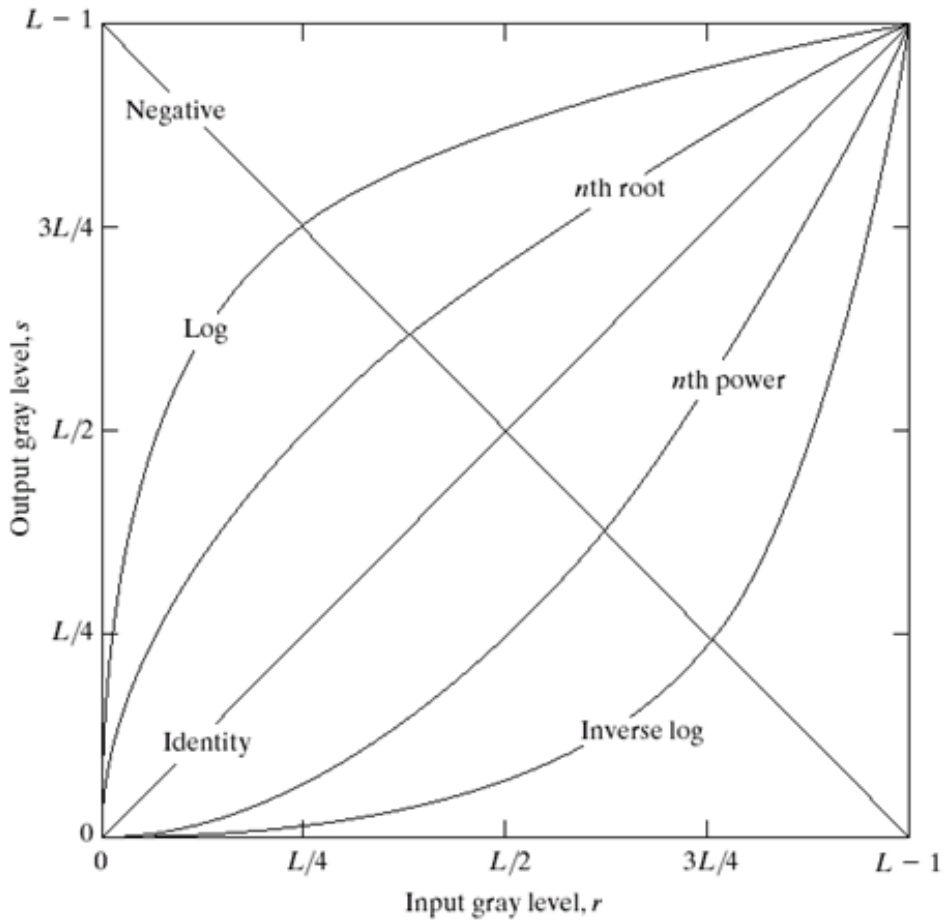
# Spatial domain techniques

Point Operations(Point Processing)

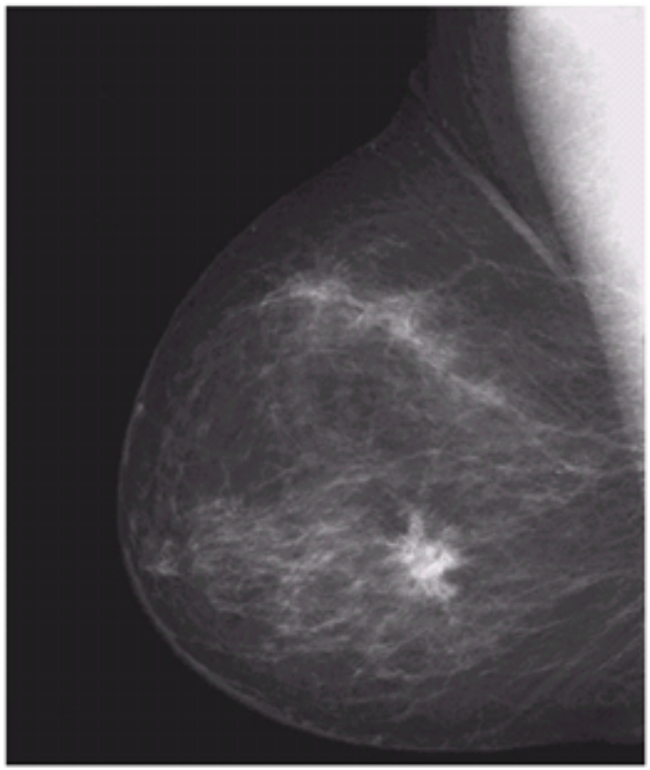
- The simplest kind of range transformations which are independent of position $(x, y)$: $g(x, y) = T[f(x, y)]$
- This is called point processing.
- Basic Point Processing Techniques are:
  - Negative of Image
  - Log Transformation
  - Power Law Transformation
  - Contrast Stretching
  - Gamma Correction

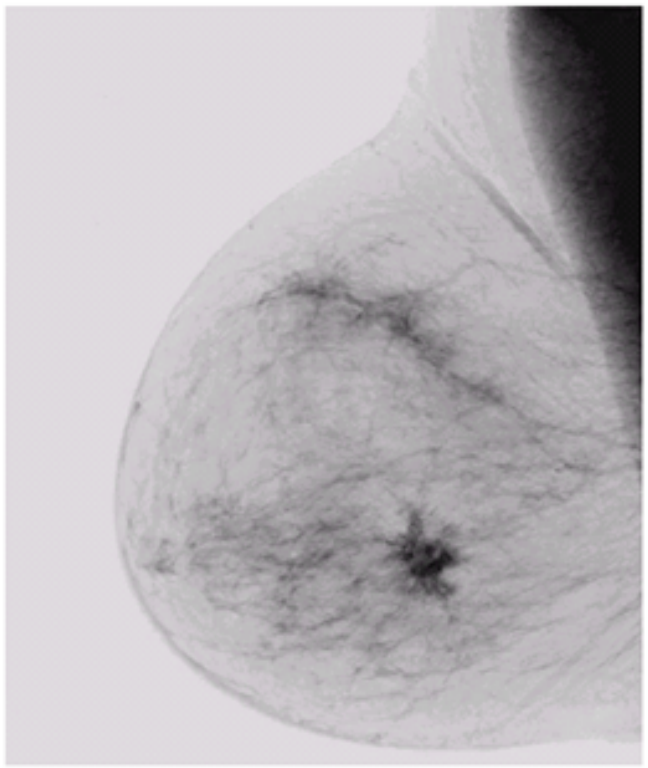
# Gray Level Transformation

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



# Negative of Image

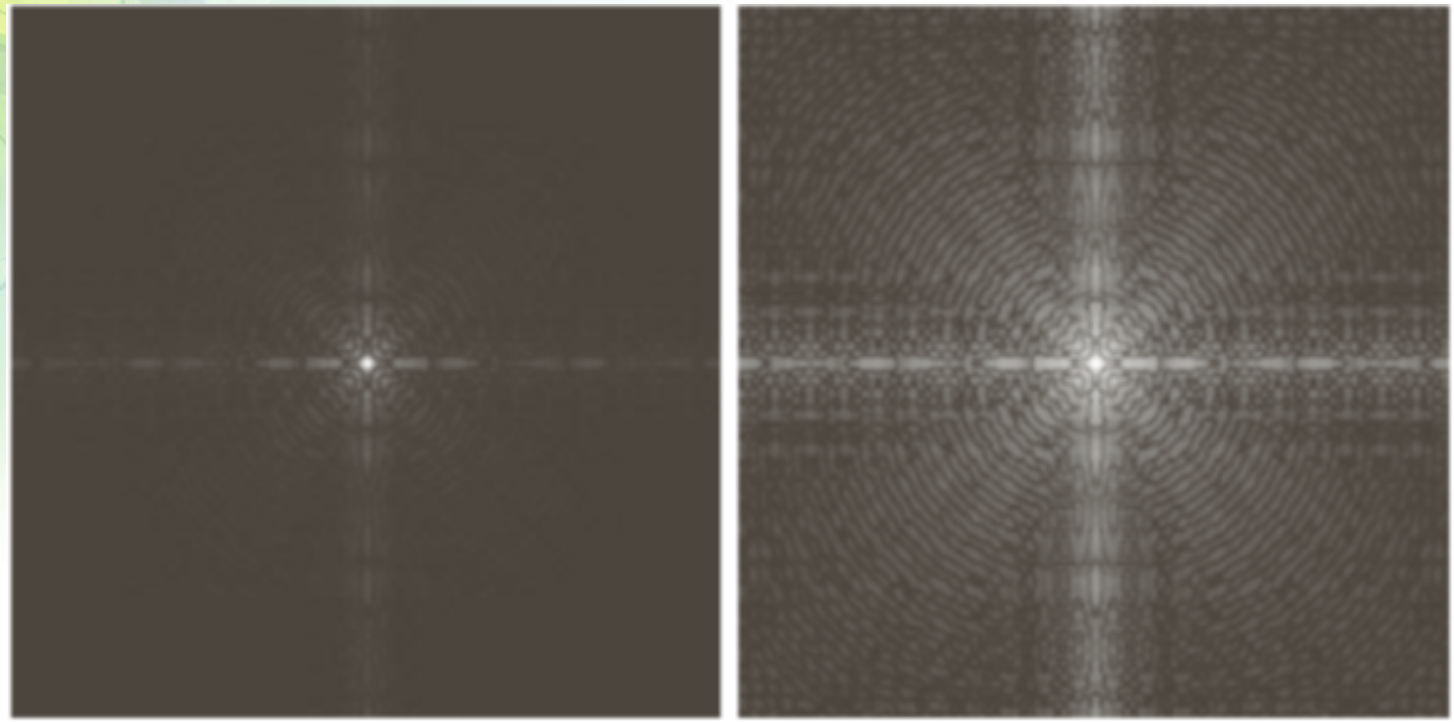




a b

**FIGURE 3.4**
(a) Original digital mammogram. (b) Negative image obtained using the negative transformation in Eq. (3.2-1). (Courtesy of G.E. Medical Systems.)

# Power Law Transformation



# Gamma Correction

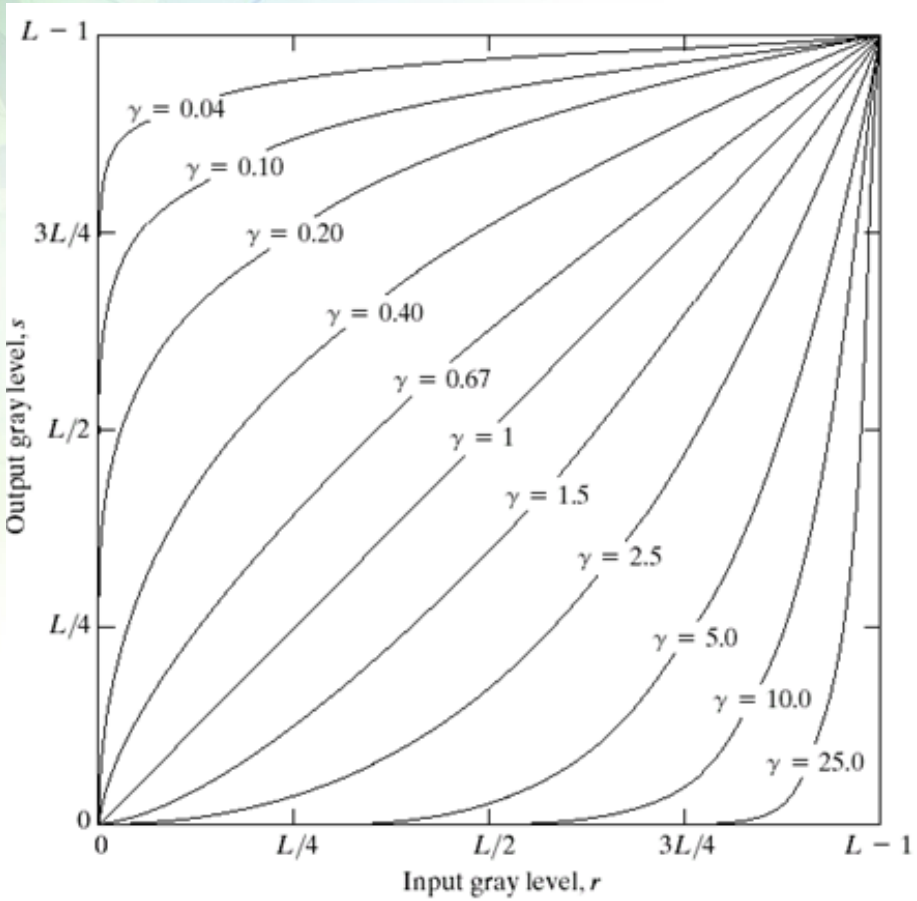
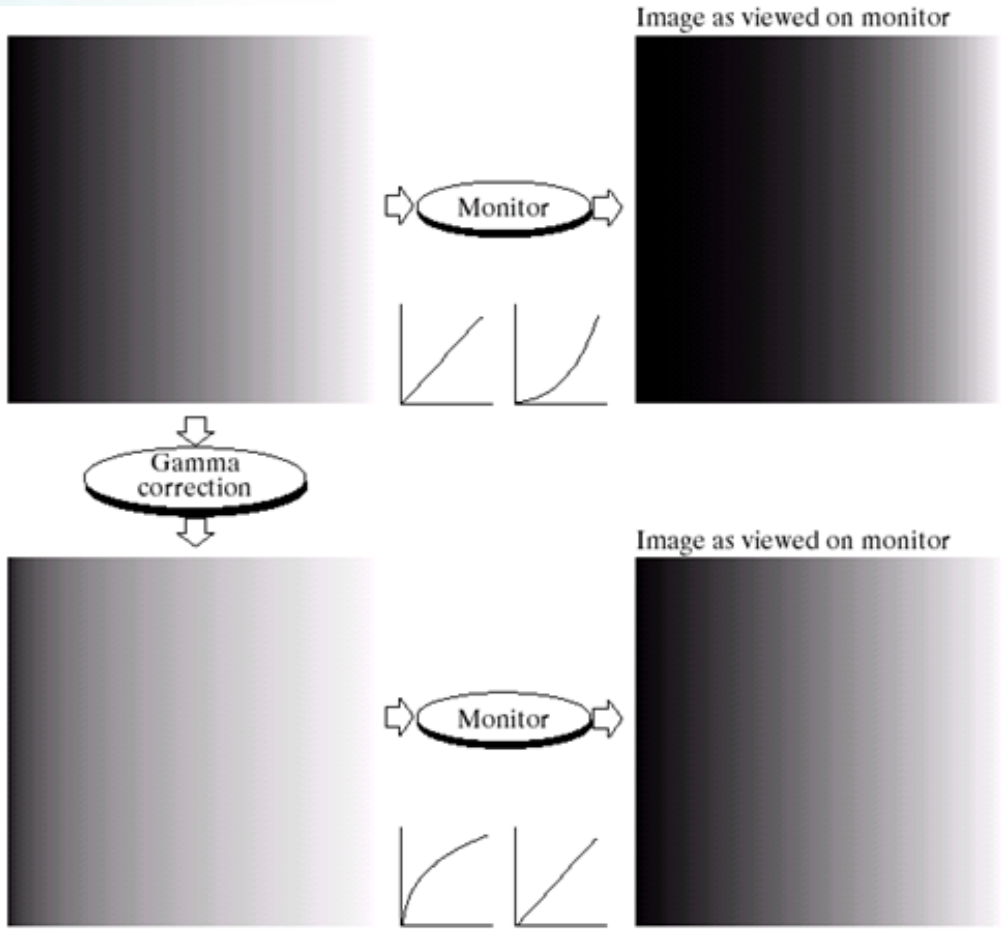



**FIGURE 3.6** Plots of the equation $s = cr^{\gamma}$ for various values of $\gamma$ ($c = 1$ in all cases).

# Different Gray Level Transformation




a b
c d

**FIGURE 3.7**
(a) Linear-wedge gray-scale image. (b) Response of monitor to linear wedge. (c) Gamma-corrected wedge. (d) Output of monitor.

# References I


1 Gonzalez, R. C., & Woods, R. E. 1. (2008). "Digital Image Processing (3rd ed.)",Prentice Hall.

2 https://en.wikipedia.org/wiki/Transformation_matrix

3 https://en.wikipedia.org/wiki/File:2D_affine_transformation_matrix.svg

# Author Information

For further information please contact

**Prof. Ashok N Shinde**
Department of Electronics & Telecommunication Engineering
Hope Foundation's
International Institute of Information Technology, $(I^2IT)$
Hinjawadi, Pune 411 057
Phone - +91 20 22933441
www.isquareit.edu.in|ashoks@isquareit.edu.in