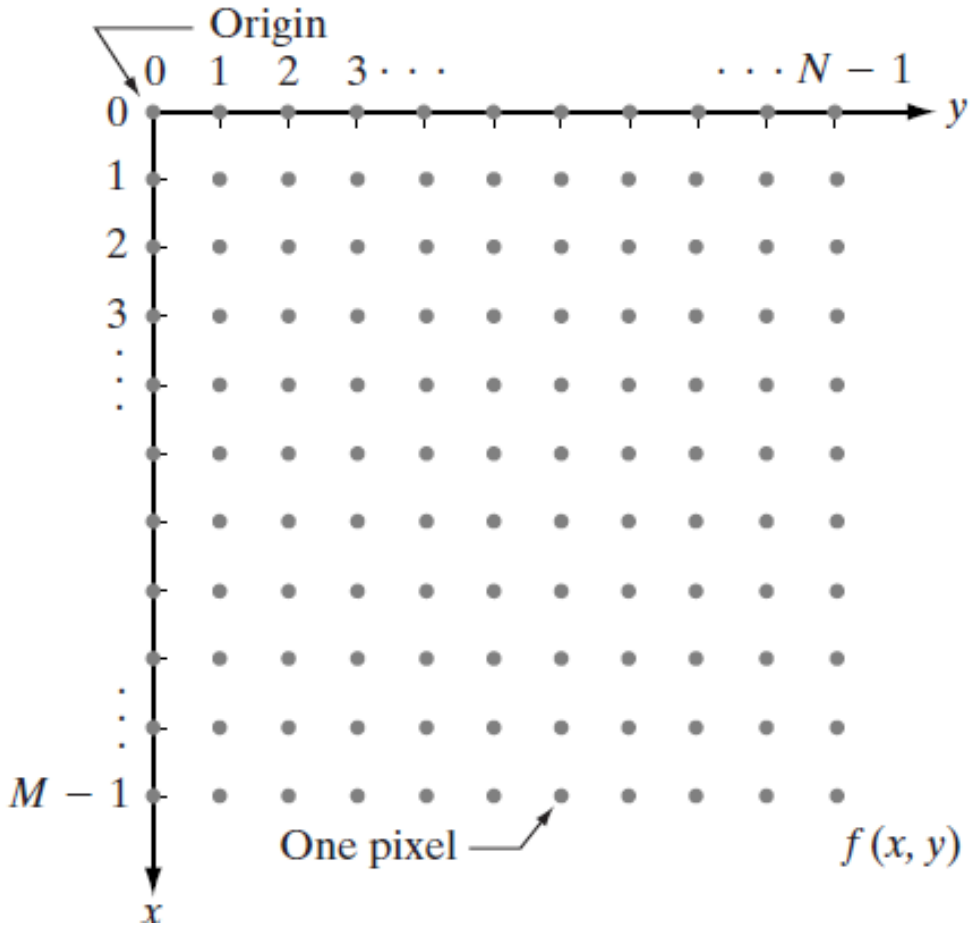

INTENSITY
TRANSFORMATIONS
Pixel to Pixel mapping

REPRESENTING DIGITAL IMAGE

value f(x,y) at each x, y is called ***intensity level*** or ***gray level***

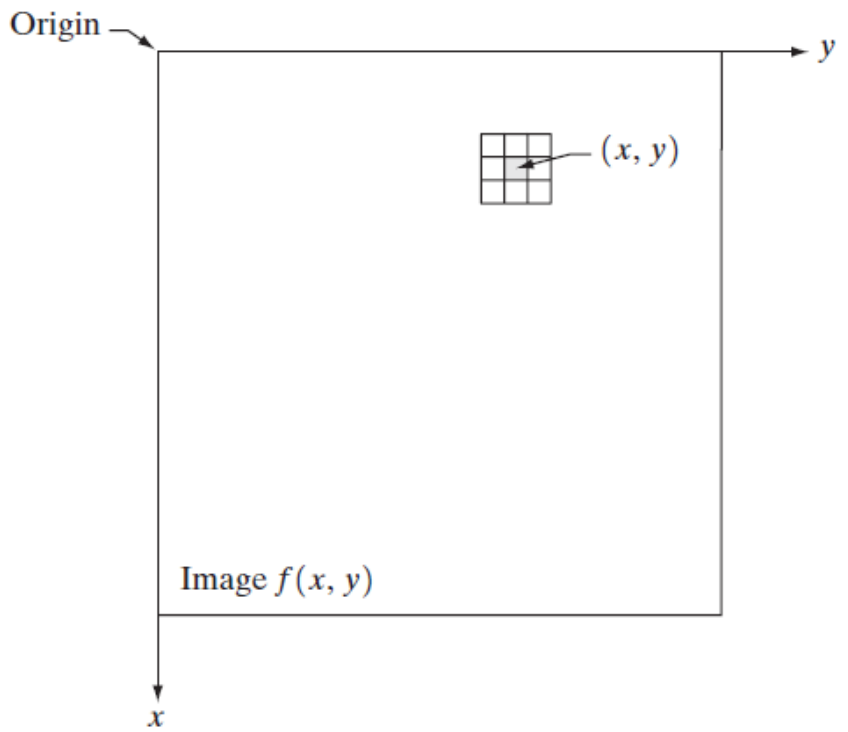


INTENSITY TRANSFORMATIONS AND FILTERS

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

f(x,y) – input image,
g(x,y) – output image
T is an operator on f defined over a neighborhood of point (x,y)

FIGURE 3.1 A 3×3 neighborhood about a point (x, y) in an image.



INTENSITY TRANSFORMATION

1 x 1 is the smallest possible neighborhood.

In this case g depends only on value of f at a single point (x,y)
and we call T an *intensity (gray-level mapping) transformation* and write

$$s = T(r)$$

where r and s denotes respectively the intensity of g and f at any point (x, y).

Thresholding

Padding (0s, 1s, Symmetric, Replicate)

INTENSITY TRANSFORMATION FUNCTIONS

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

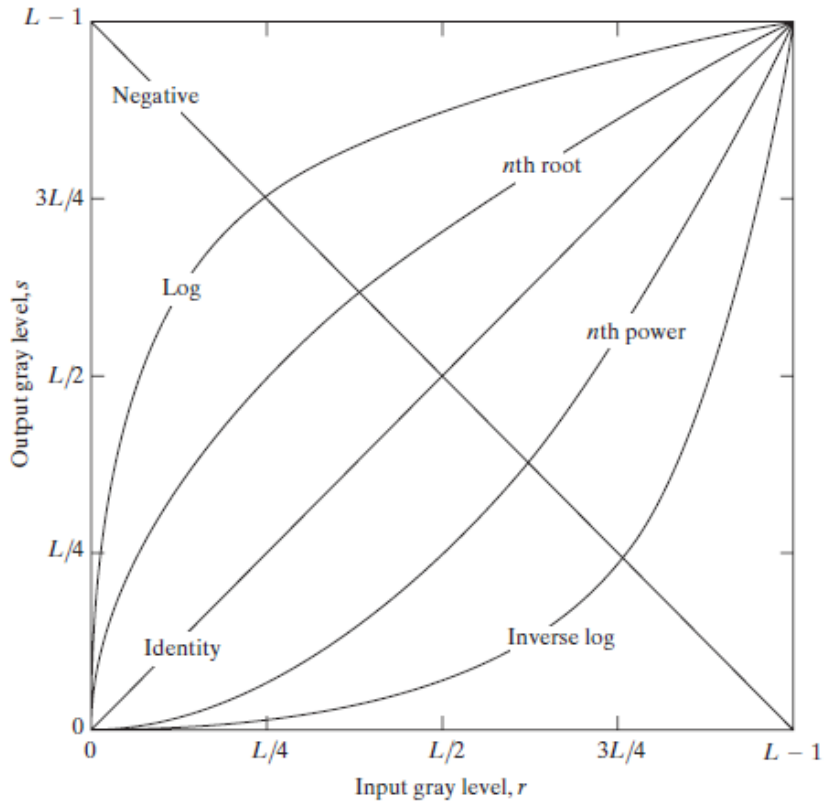
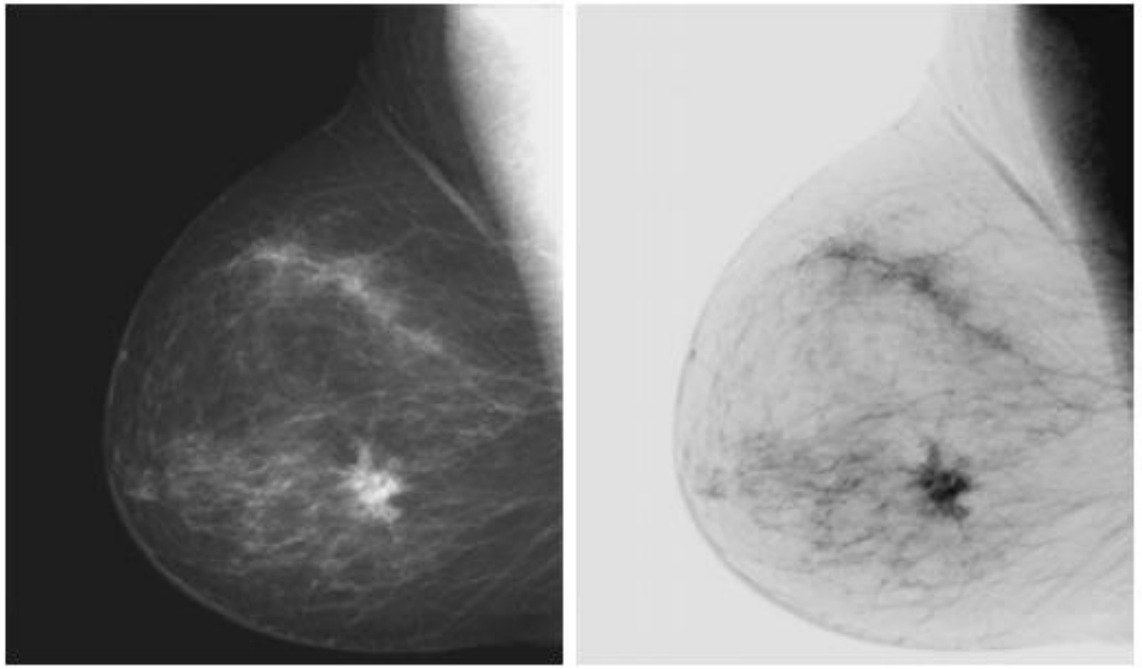


IMAGE NEGATIVES

Denote [0, L-1] intensity levels of the image.

Image negative is obtained by ***s= L-1-r***



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.)

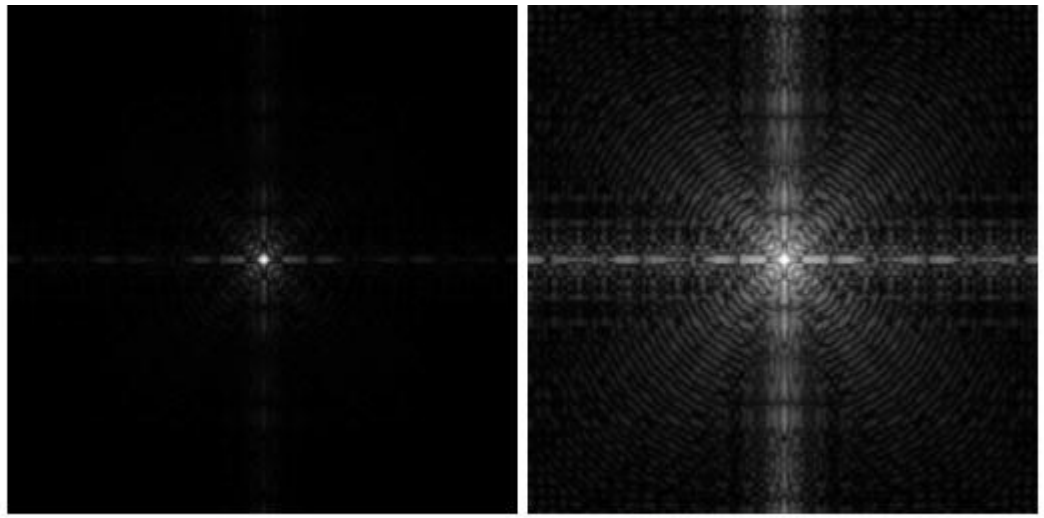
LOG TRANSFORMATIONS

$s = c\log(1+r)$, c – const, $r \geq 0$

Maps a narrow range of low intensity values in the input into a wider range of output levels. The opposite is true for higher values of input levels.

a b

FIGURE 3.5
(a) Fourier spectrum.
(b) Result of applying the log transformation given in Eq. (3.2-2) with $c = 1$.



POWER–LAW (GAMMA) TRANSFORMATION

$s = cr^{\gamma}$, c,γ – *positive constants*

curve the grayscale components either to brighten the intensity (when $\gamma < 1$)

or darken the intensity (when $\gamma > 1$).

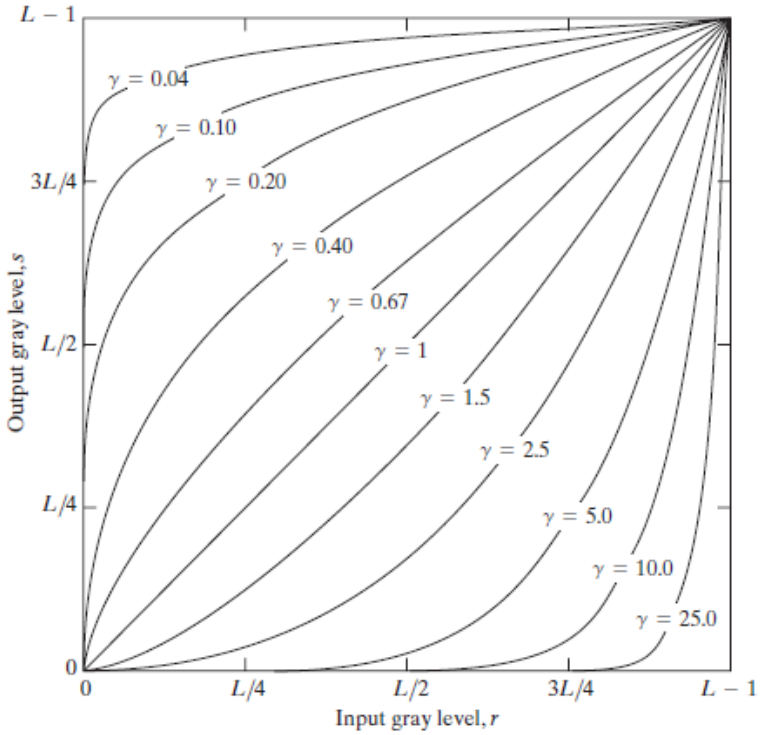
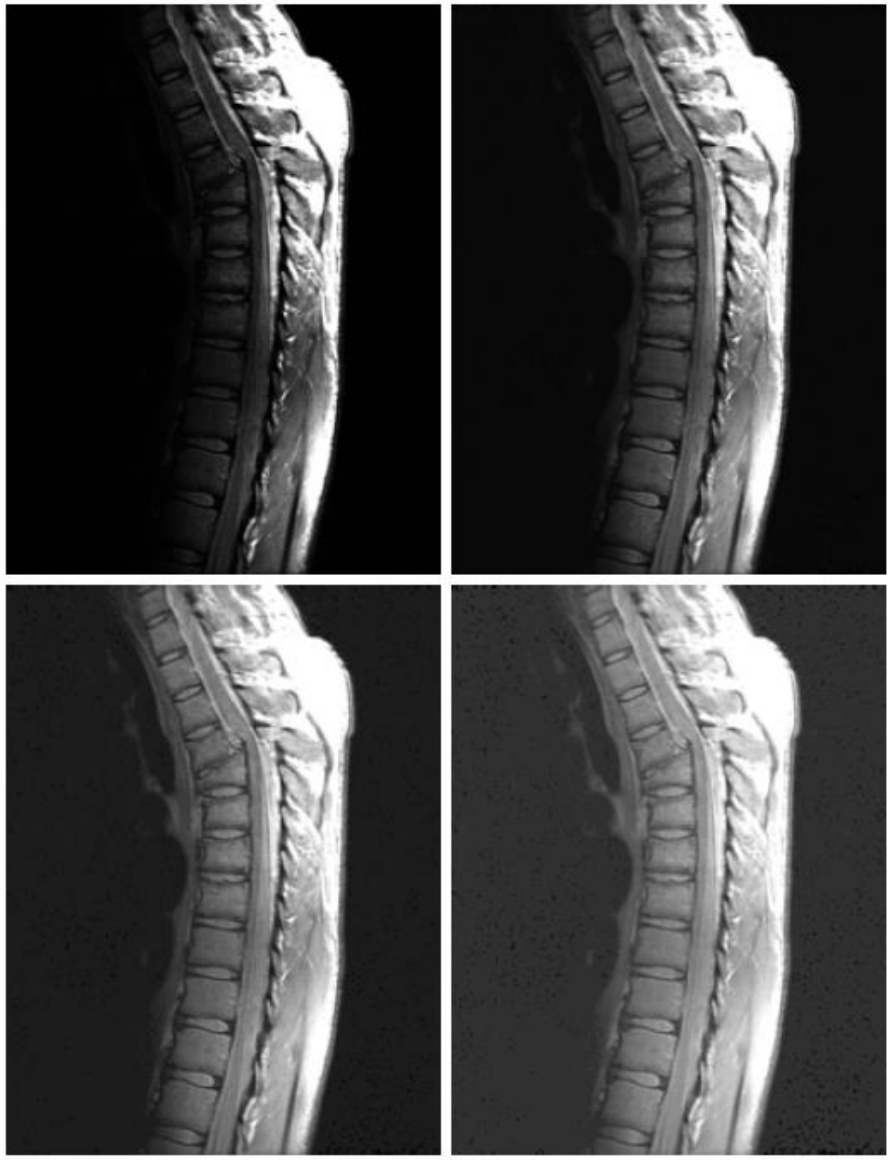


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases).

POWER –LAW (GAMMA) TRANSFORMATION



a b
c d

FIGURE 3.8
(a) Magnetic resonance (MR) image of a fractured human spine.
(b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 0.6, 0.4$, and 0.3, respectively. (Original image for this example courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

POWER –LAW (GAMMA) TRANSFORMATION

a b
c d

FIGURE 3.9
(a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0$, and 5.0, respectively. (Original image for this example courtesy of NASA.)