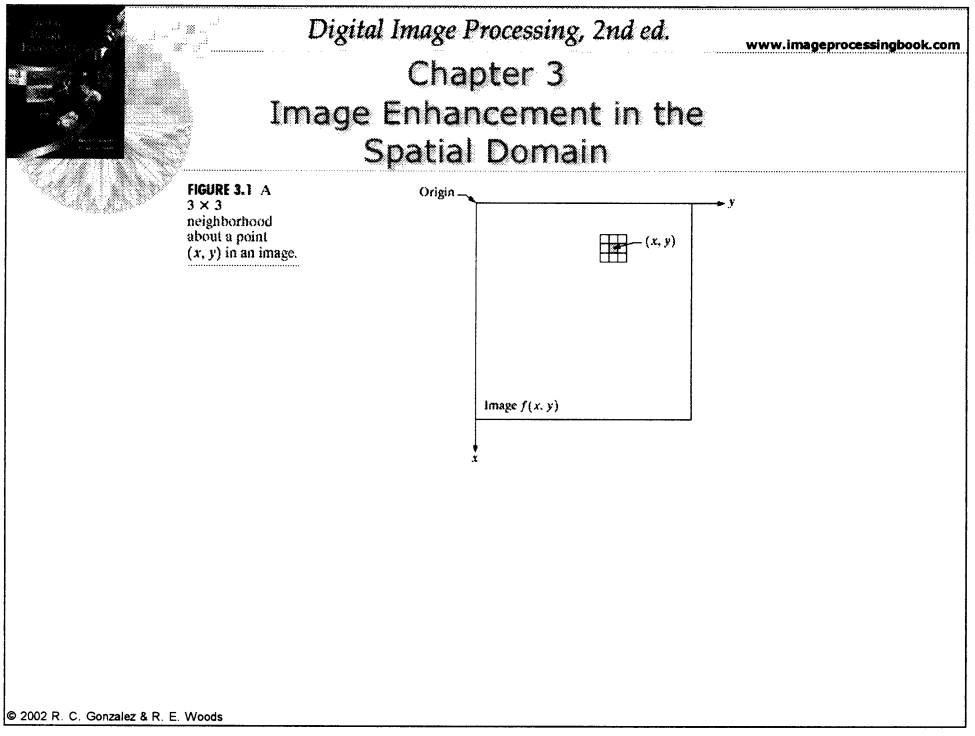
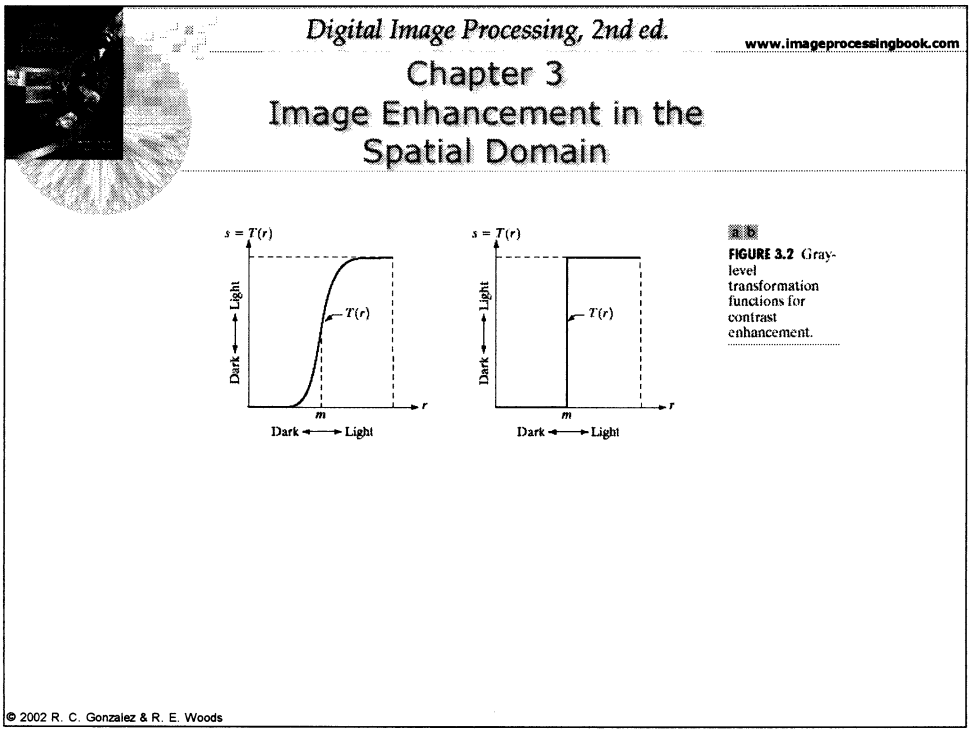
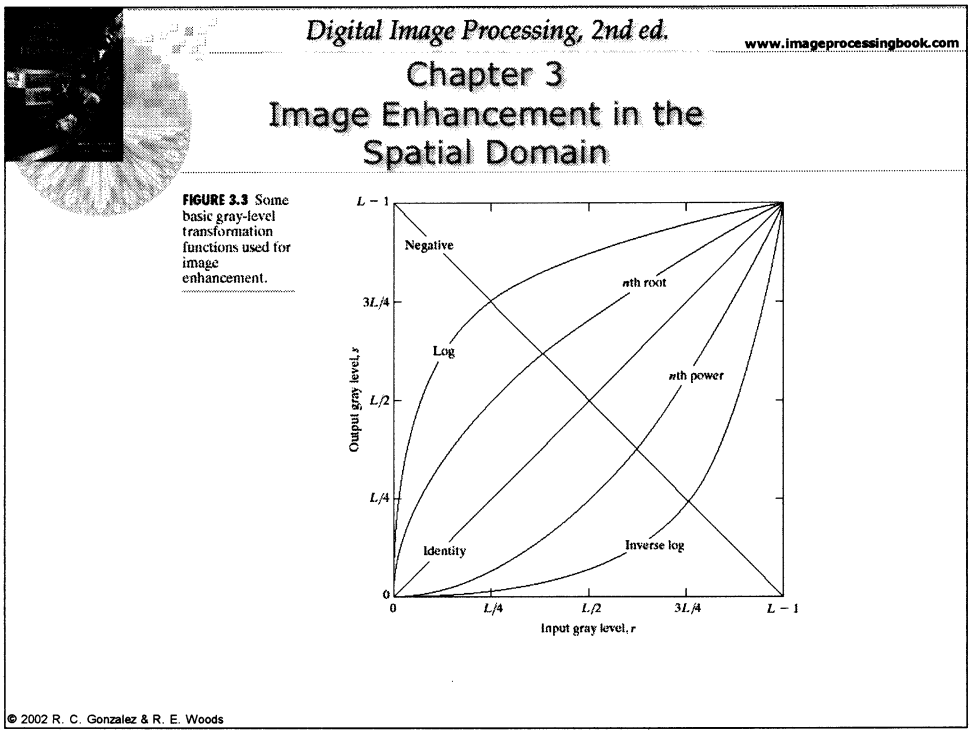


Neighborhoods usually 3×3 but often larger
5×5
7×7
odd so centered on (x,y)



These are point to point intensity transformations.



This is a logarithmic gray level transformation.

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

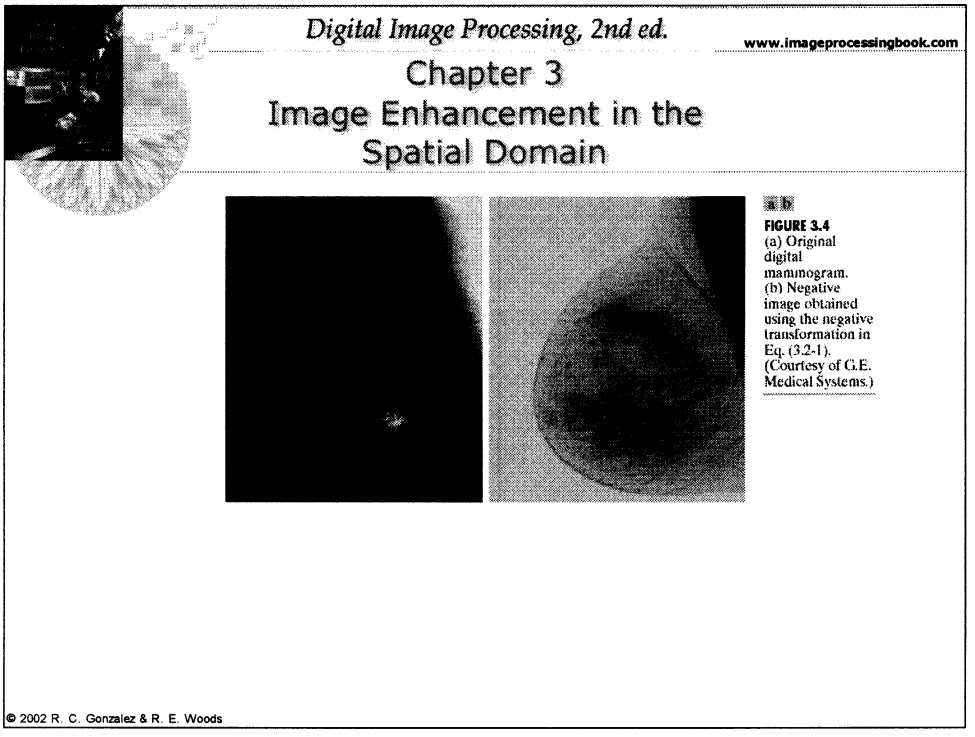
output gray level

constant

input gray level

This type of transform expands/compresses the gray levels of the input.

It can expand dark pixel values.

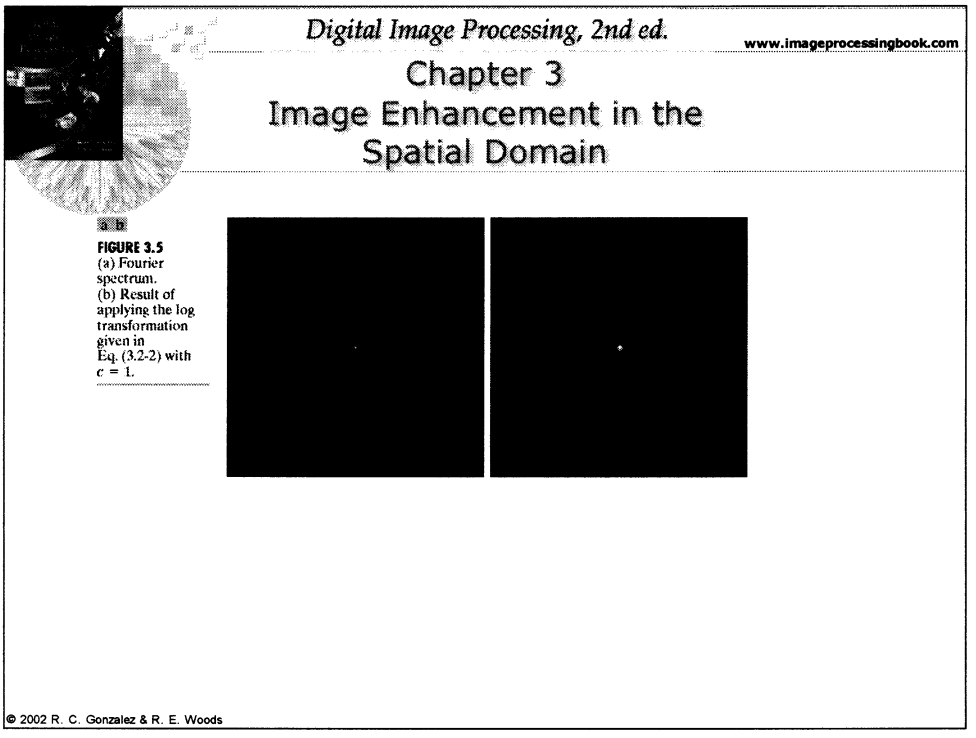


(b) is simply the negative of (a), i.e.,

$$s = L - 1 - r \qquad \text{where } L = 2^k$$

k: # of bits

L: # of gray levels



This is an example of $S = \log(1+r)$ used to make dark information on monitor more visible.

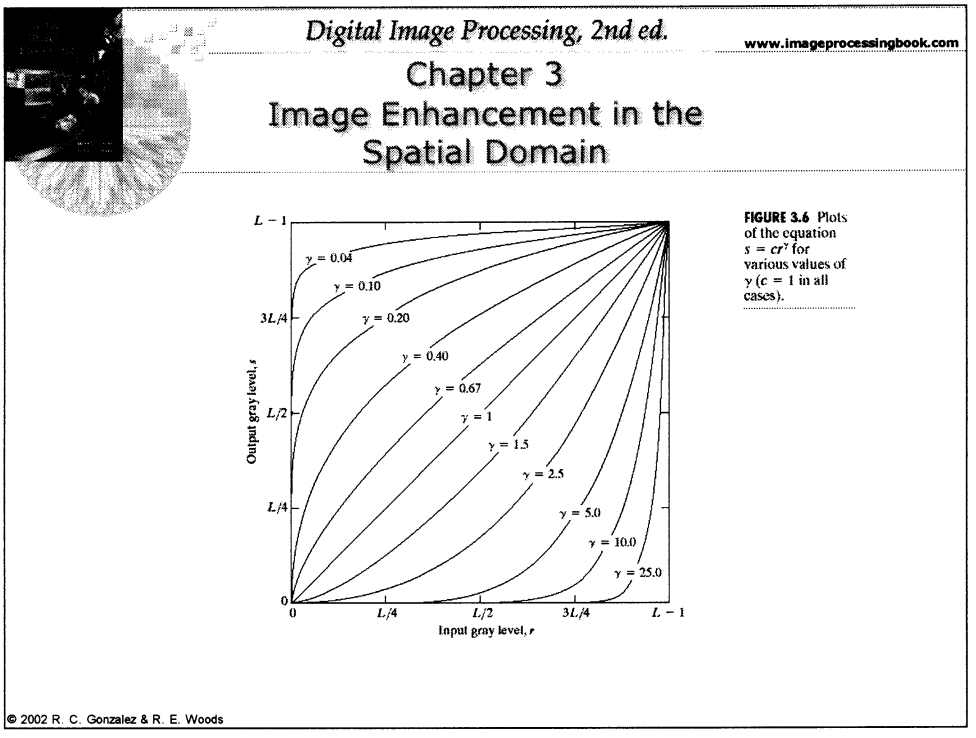
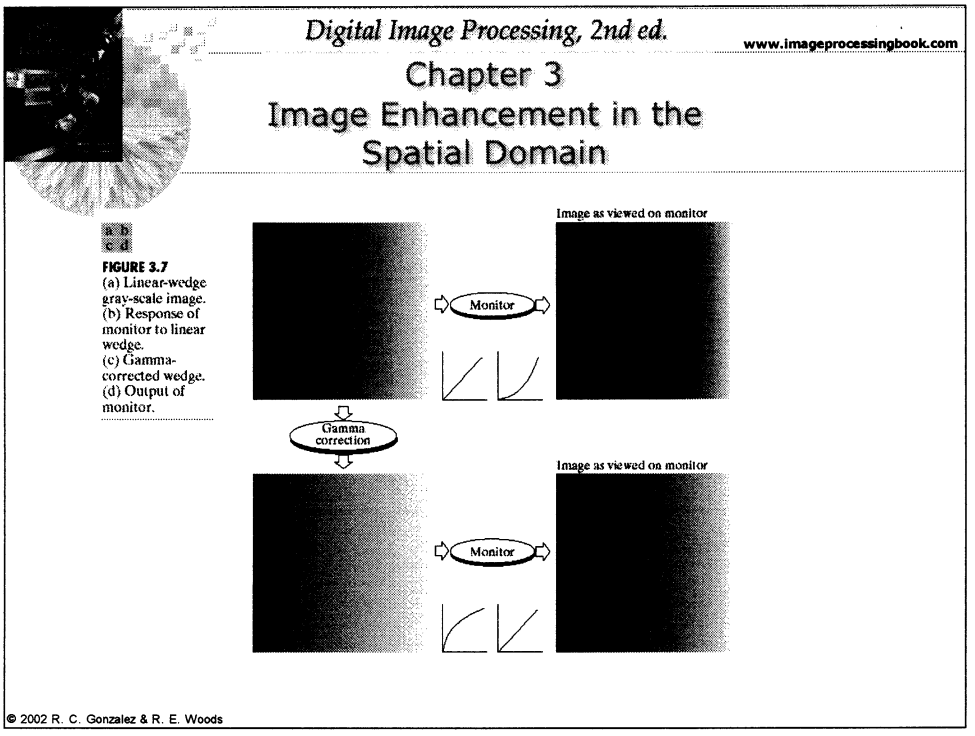


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases).

Power law transform $s = cr^{\gamma}$

γ ↑ gamma



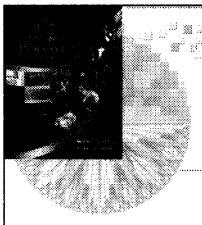
This is an example of using a γ transformation to correct for a monitor produced $s = r^{2.5}$

First transform the computer data to get $r' = r^{\frac{1}{2.5}}$

Then, $s = (r')^{2.5}$ by the monitor

$$s = \left(r^{\frac{1}{2.5}}\right)^{2.5} = r$$

This is called γ correction.



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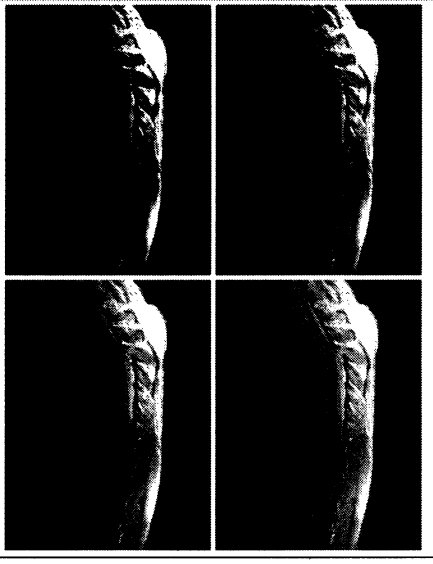
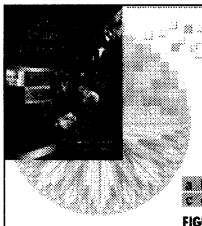


FIGURE 3.8
(a) Magnetic resonance (MR) image of a fractured human spine. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 0.6, 0.4$, and 0.3, respectively. (Original image for this example courtesy of Dr. David R. Pickens, Department of Radiology and Radiological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



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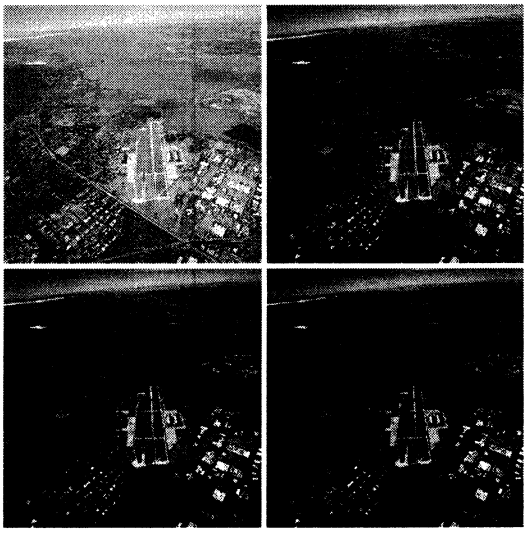
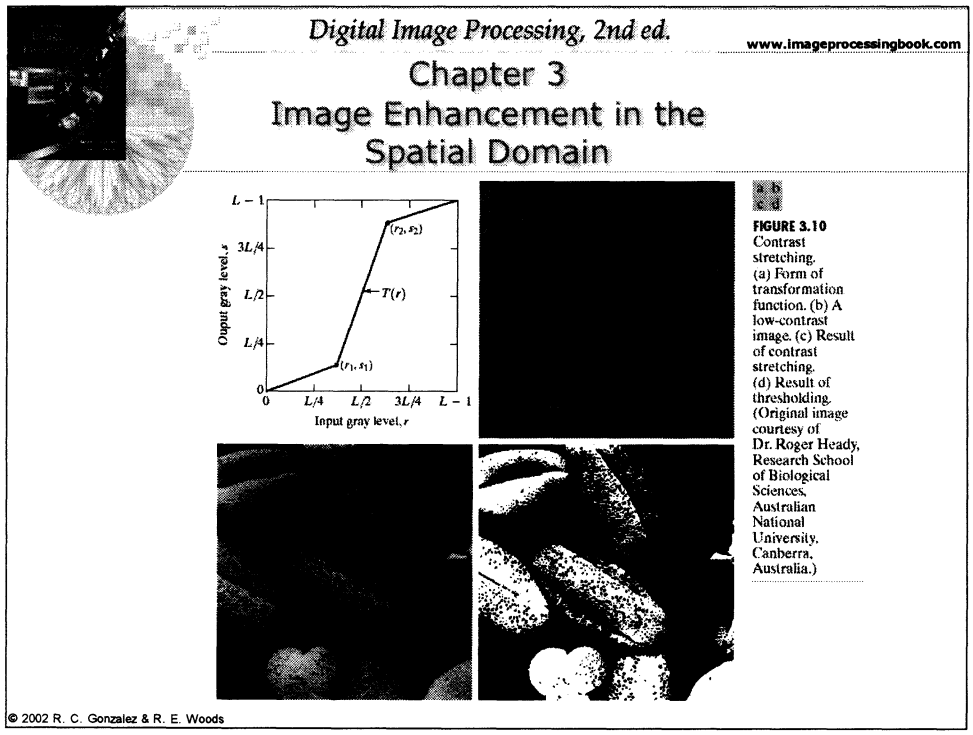
a b
c d

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.)

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L − 1
3L/4
L/2
L/4
0
Ouput gray level, s
(r2, s2)
T(r)
(r1, s1)
0
L/4
L/2
3L/4
L − 1
Input gray level, r
FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)
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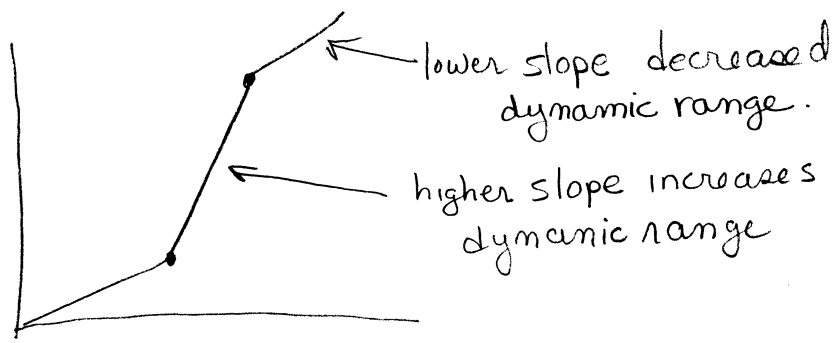
lower slope decreased dynamic range.
higher slope increases dynamic range

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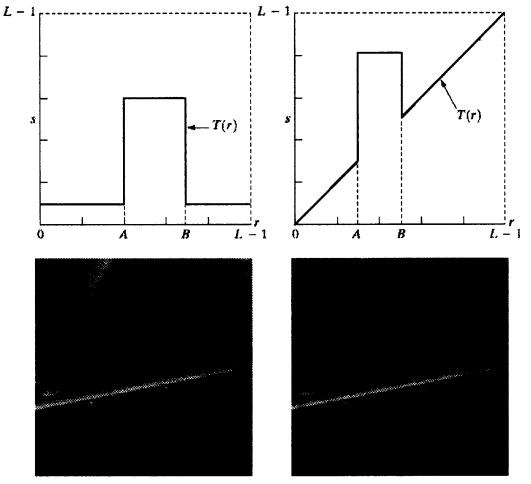
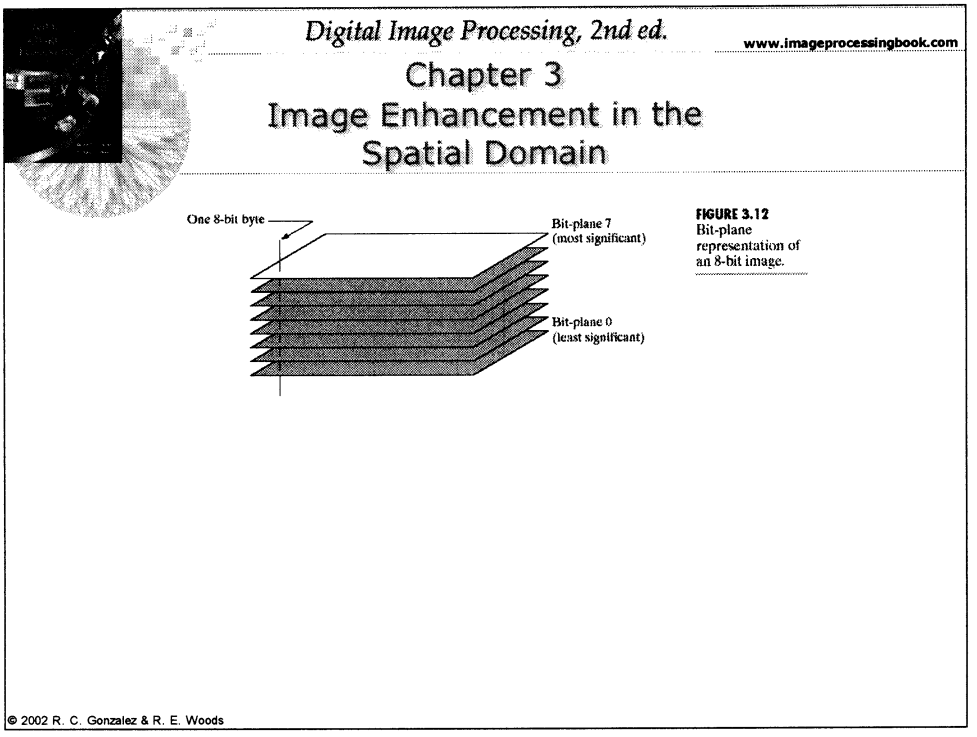


a b
c d

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).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One 8-bit byte
Bit-plane 7 (most significant)
Bit-plane 0 (least significant)
FIGURE 3.12 Bit-plane representation of an 8-bit image.
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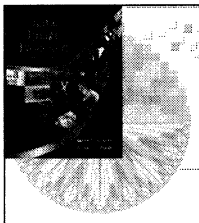

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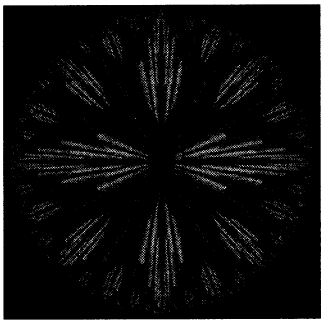

FIGURE 3.13 An 8-bit fractal image. (A fractal is an image generated from mathematical expressions). (Courtesy of Ms. Melissa D. Binde, Swarthmore College, Swarthmore, PA.)

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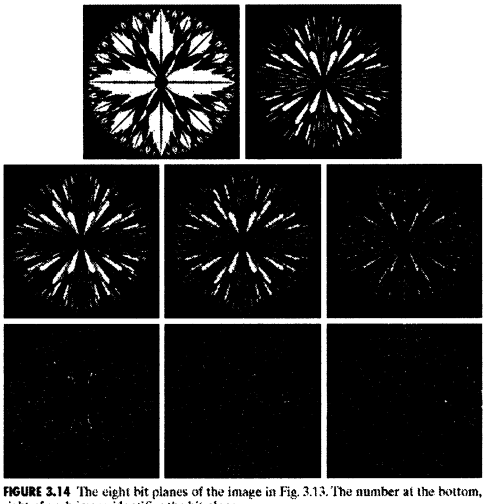


FIGURE 3.14 The eight bit planes of the image in Fig. 3.13. The number at the bottom, right of each image identifies the bit plane.

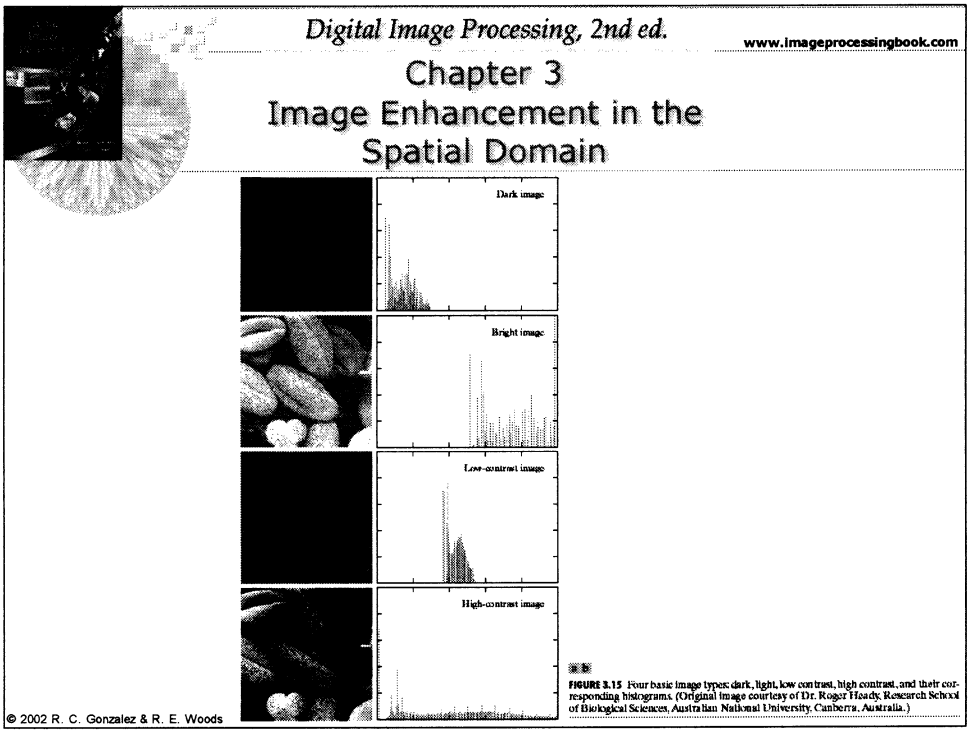
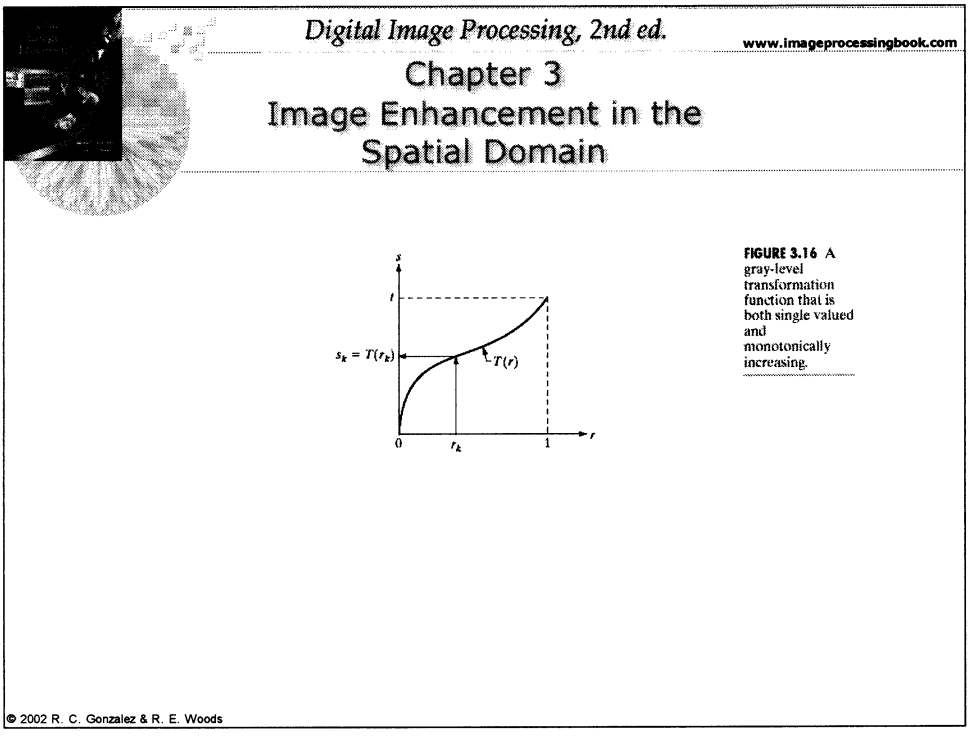
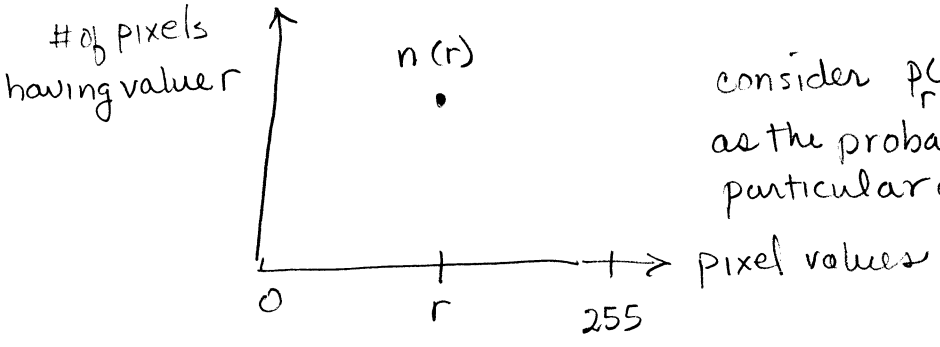


FIGURE 3.15 Four basic image types: dark, light, low contrast, high contrast, and their corresponding histograms. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)





consider $p_r(r) = \frac{n(r)}{n}$ as the probability of a particular gray level r.

Then $s = T(r) = \int_0^r p_r(w)\,dw$

This is a cumulative distribution function if we consider $p_r(r)$ to be a probability density function.

$T(r)$ is single valued and monotonically increasing.
for $0 \le r \le 1$

$0 \le T(r) \le 1$ for $0 \le r \le 1$