

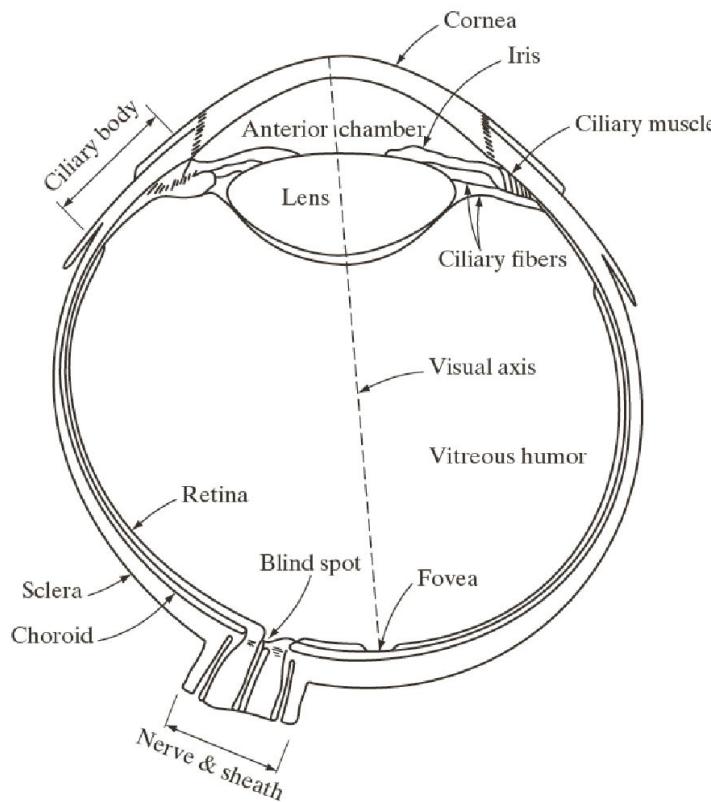
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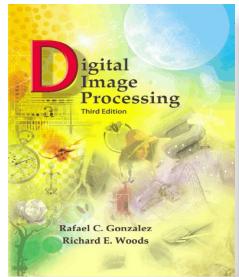
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### Digital Image Fundamentals



**FIGURE 2.1**  
Simplified  
diagram of a cross  
section of the  
human eye.



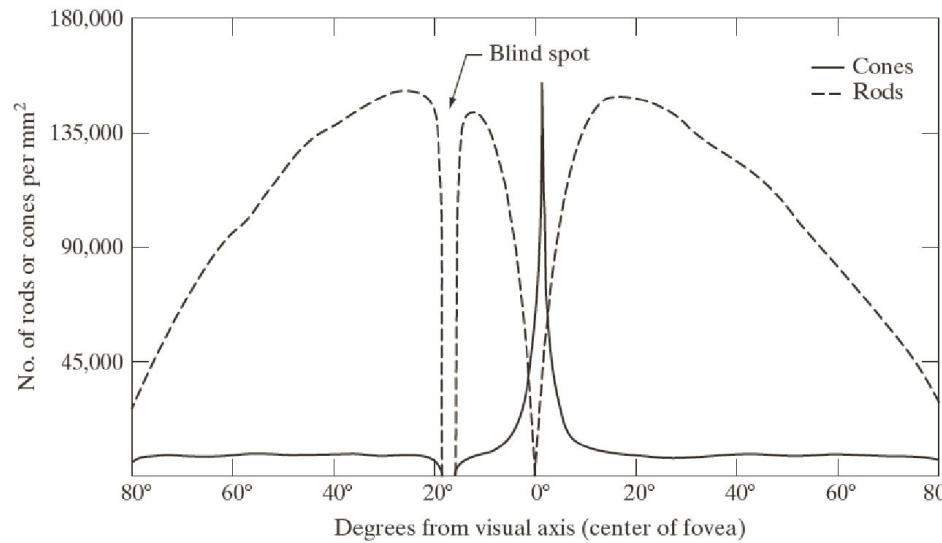
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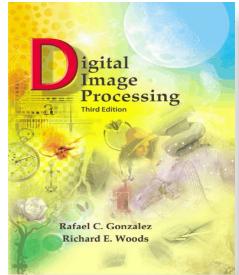
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**FIGURE 2.2**  
Distribution of rods and cones in the retina.



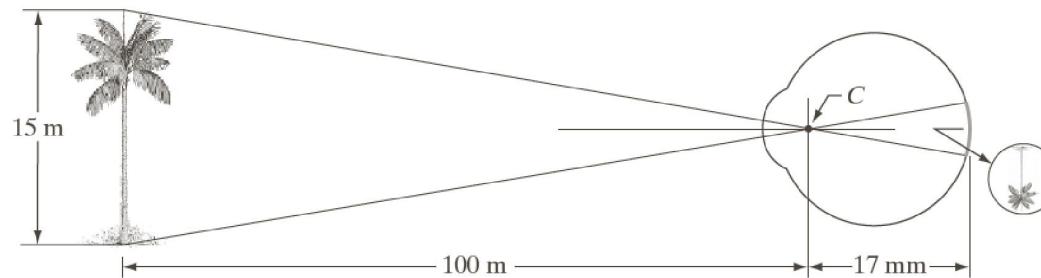
# Digital Image Processing, 3rd ed.

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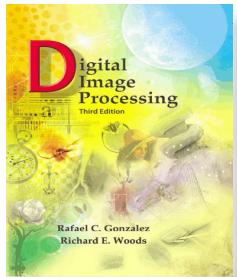
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**FIGURE 2.3**  
Graphical representation of the eye looking at a palm tree. Point C is the optical center of the lens.



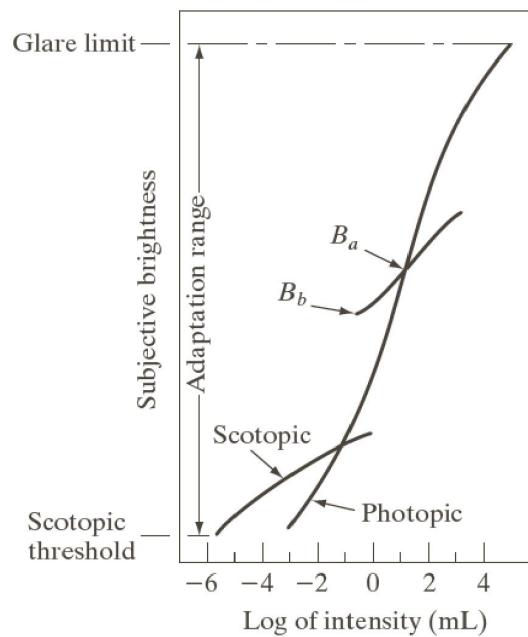
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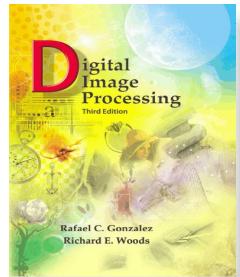
## Chapter 2

### Digital Image Fundamentals



**FIGURE 2.4**

Range of subjective brightness sensations showing a particular adaptation level.



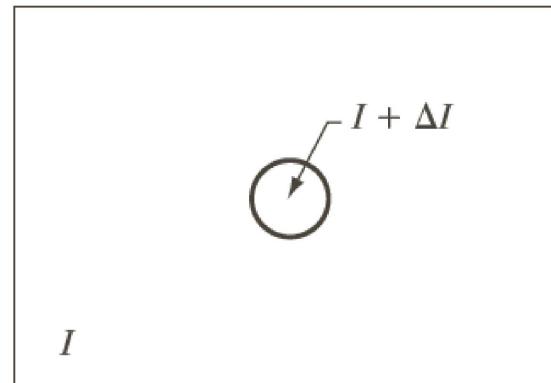
# Digital Image Processing, 3rd ed.

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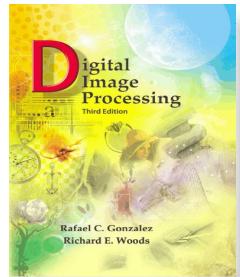
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**FIGURE 2.5** Basic experimental setup used to characterize brightness discrimination.



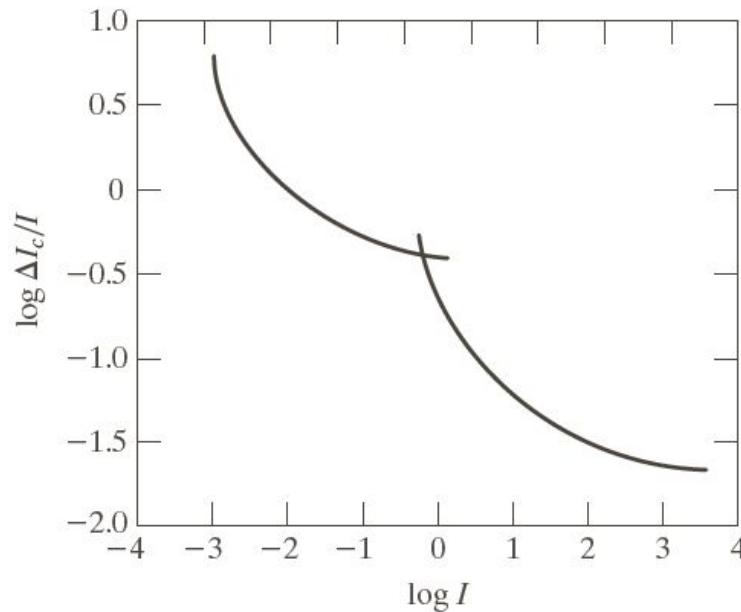
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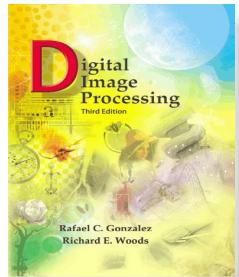
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**FIGURE 2.6**  
Typical Weber  
ratio as a function  
of intensity.



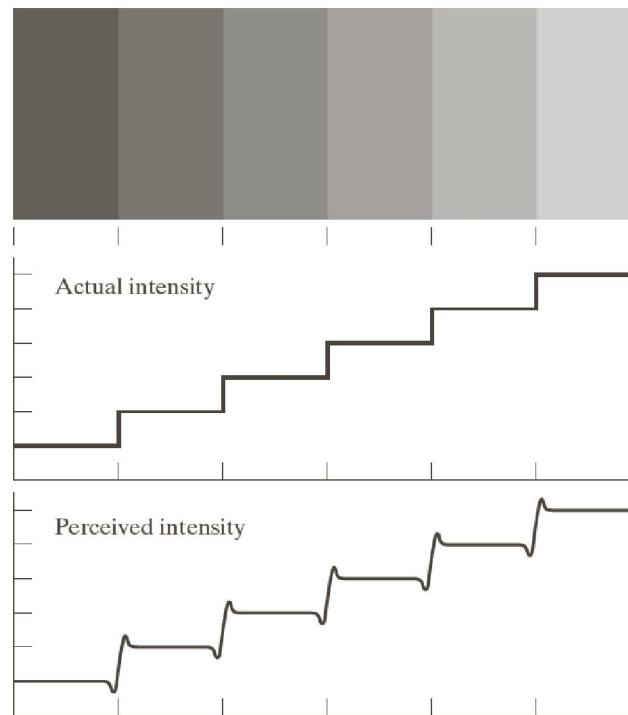
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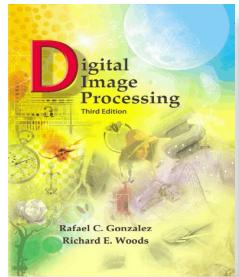
### Digital Image Fundamentals



a  
b  
c

**FIGURE 2.7**

Illustration of the Mach band effect. Perceived intensity is not a simple function of actual intensity.



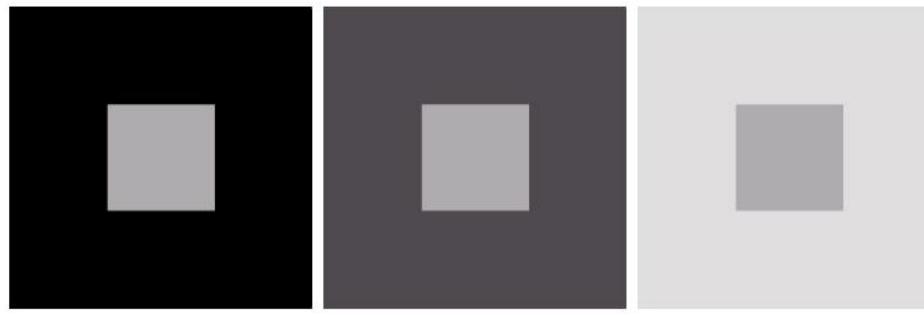
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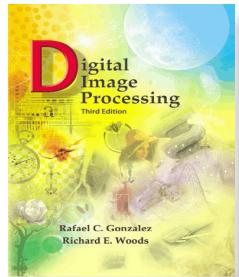
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### Digital Image Fundamentals



a b c

**FIGURE 2.8** Examples of simultaneous contrast. All the inner squares have the same intensity, but they appear progressively darker as the background becomes lighter.



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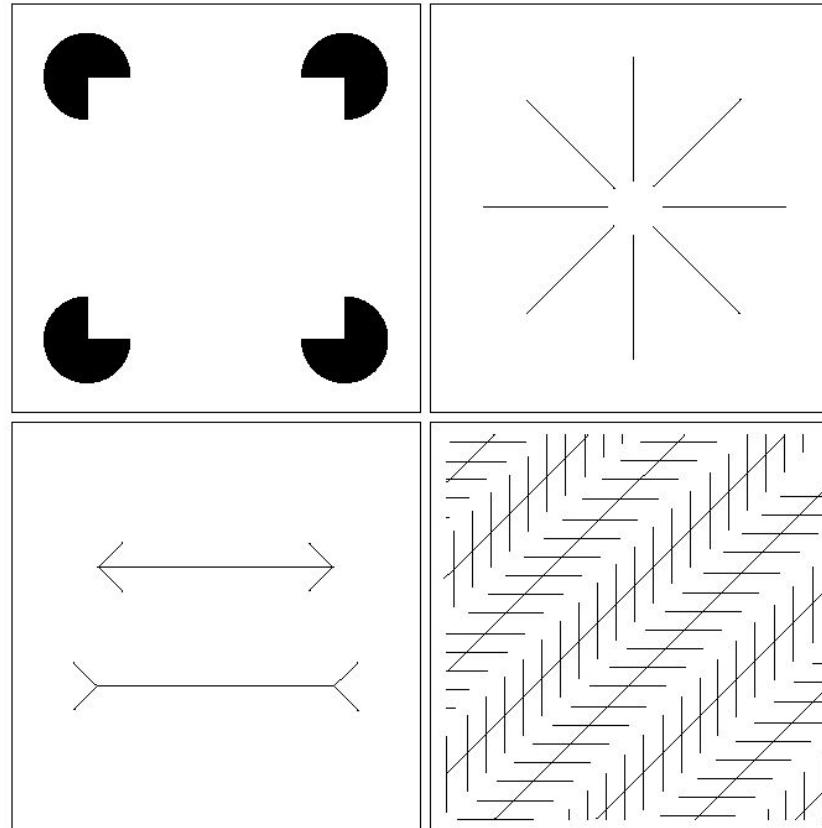
[www.ImageProcessingPlace.com](http://www.ImageProcessingPlace.com)

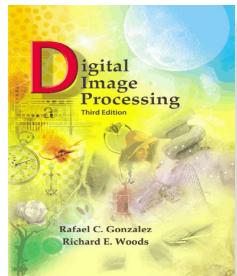
## Chapter 2

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a  
b  
c  
d

**FIGURE 2.9** Some well-known optical illusions.



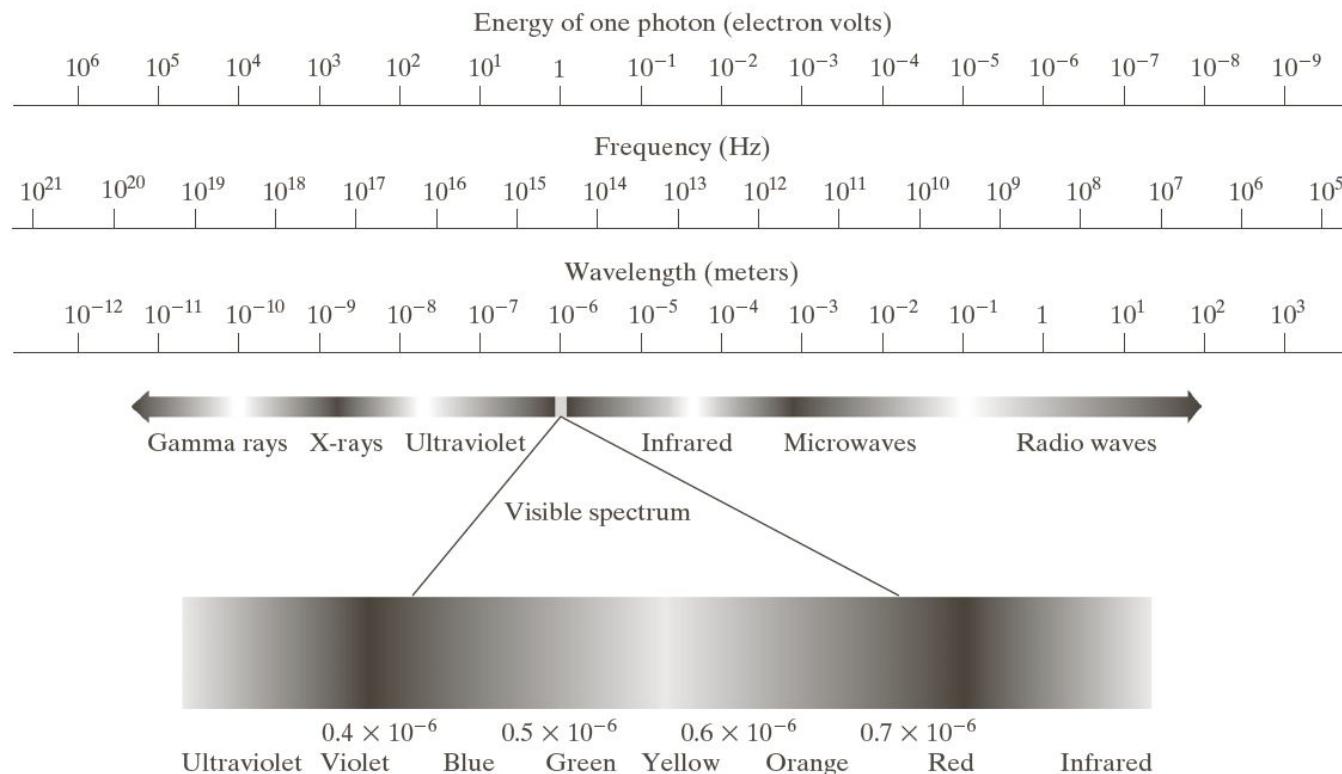


# Digital Image Processing, 3rd ed.

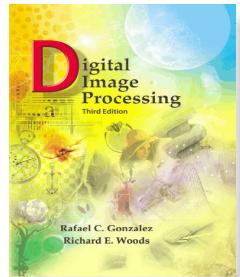
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**FIGURE 2.10** The electromagnetic spectrum. The visible spectrum is shown zoomed to facilitate explanation, but note that the visible spectrum is a rather narrow portion of the EM spectrum.



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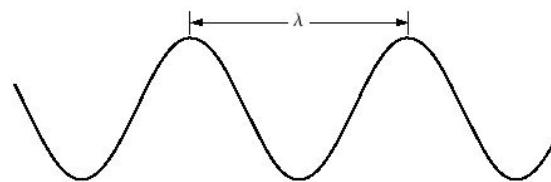
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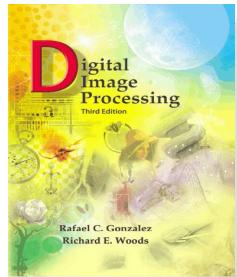
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**FIGURE 2.11**  
Graphical representation of one wavelength.



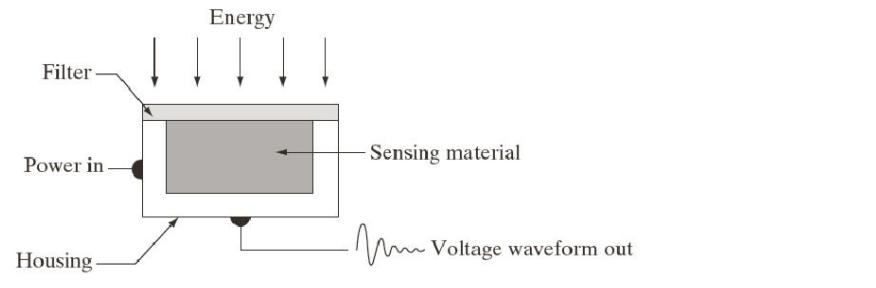


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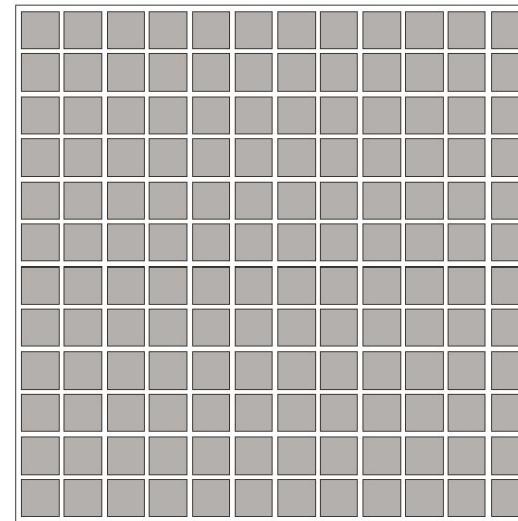
[www.ImageProcessingPlace.com](http://www.ImageProcessingPlace.com)

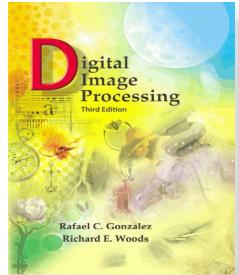
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a  
b  
c

**FIGURE 2.12**  
(a) Single imaging sensor.  
(b) Line sensor.  
(c) Array sensor.





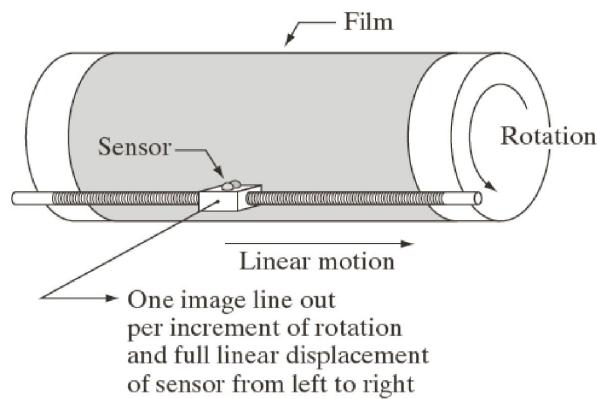
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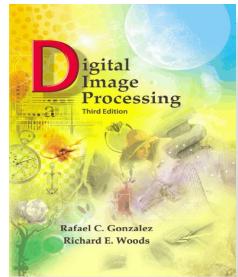
## Chapter 2

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**FIGURE 2.13**

Combining a single sensor with motion to generate a 2-D image.

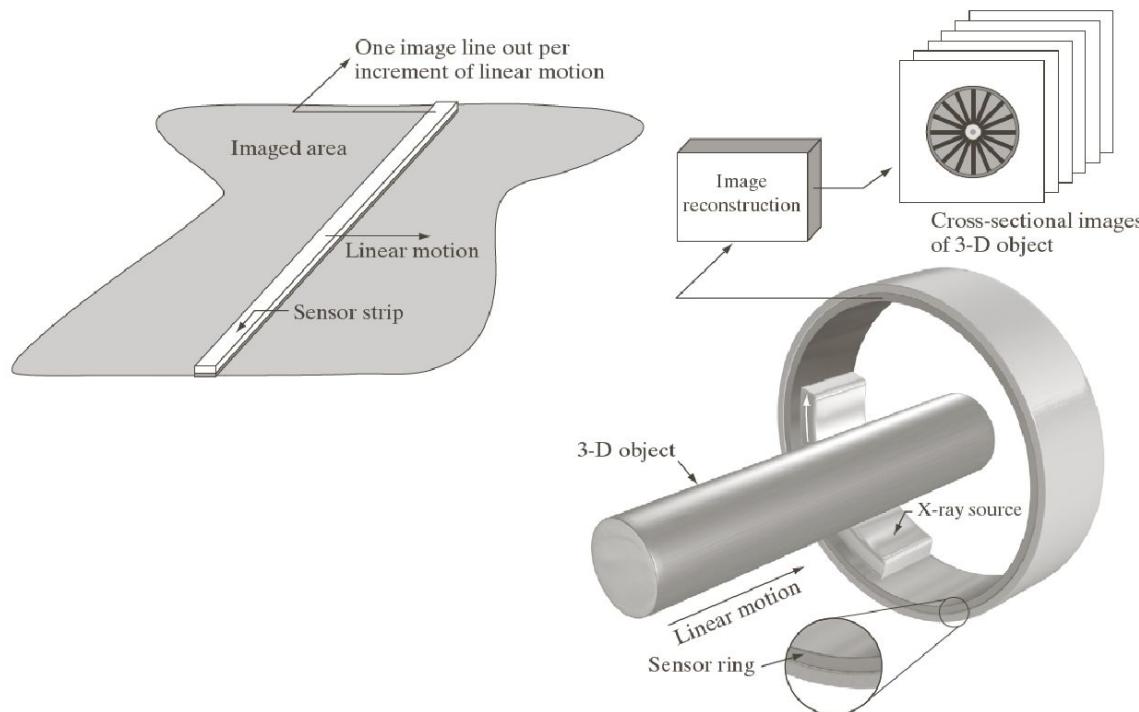


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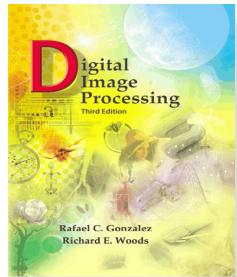
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**FIGURE 2.14** (a) Image acquisition using a linear sensor strip. (b) Image acquisition using a circular sensor strip.

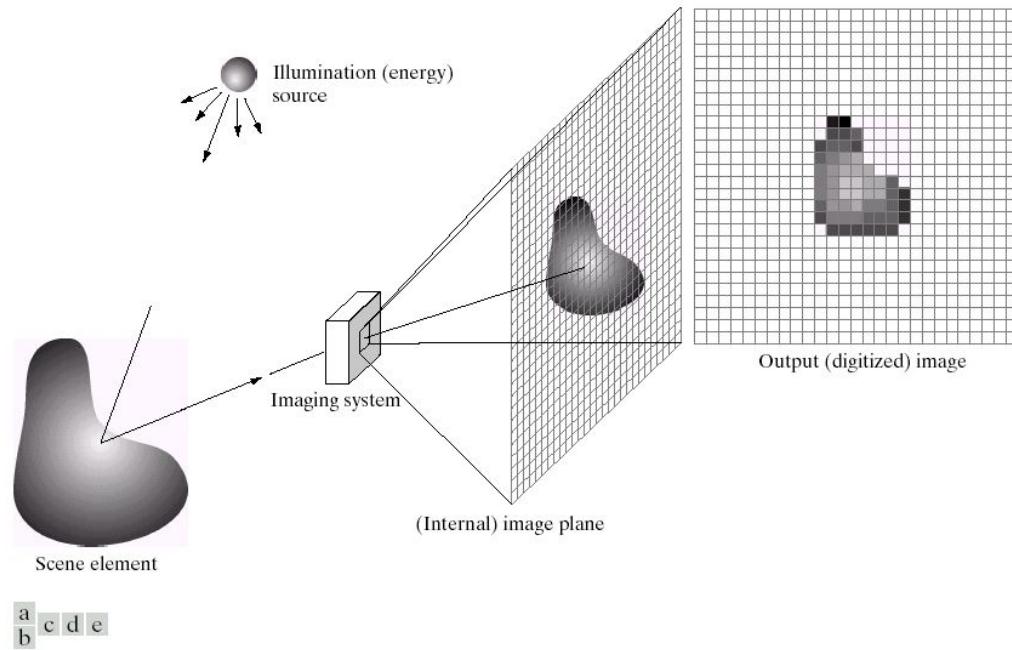


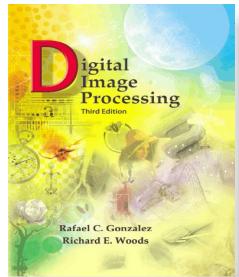
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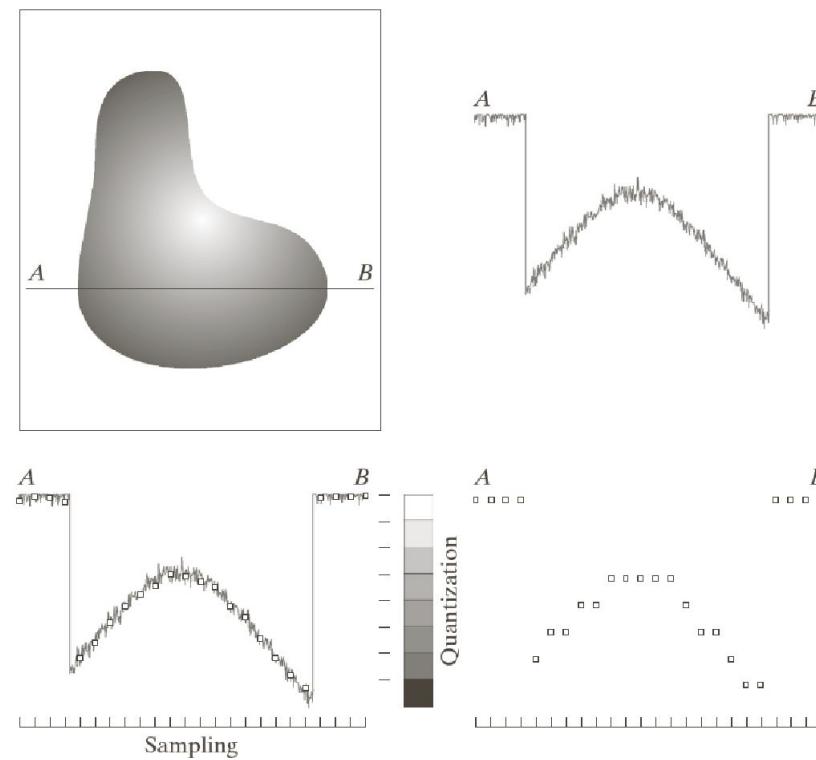
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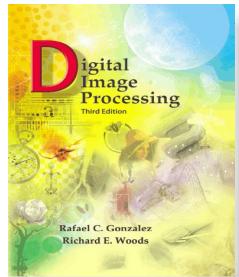
## Chapter 2

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a  
b  
c  
d

**FIGURE 2.16**  
Generating a digital image.  
(a) Continuous image.  
(b) A scan line from A to B in the continuous image, used to illustrate the concepts of sampling and quantization.  
(c) Sampling and quantization.  
(d) Digital scan line.

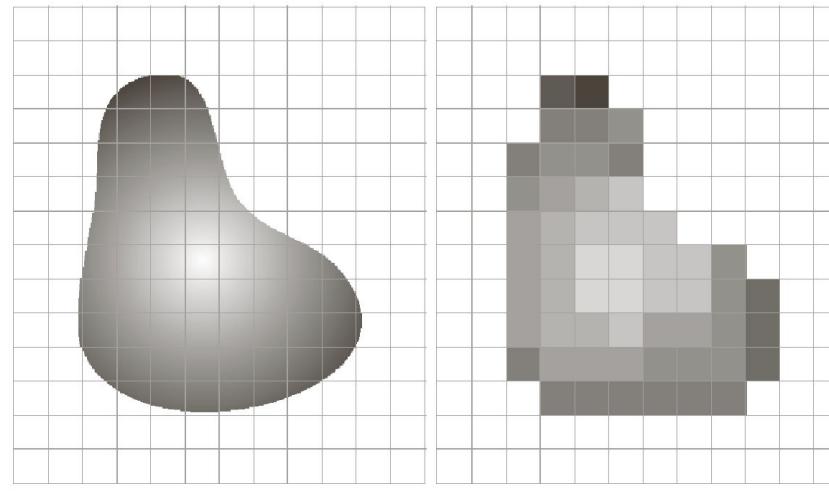


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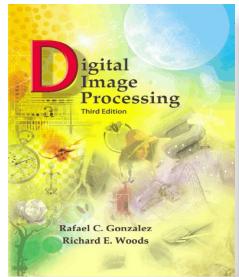
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a b

**FIGURE 2.17** (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

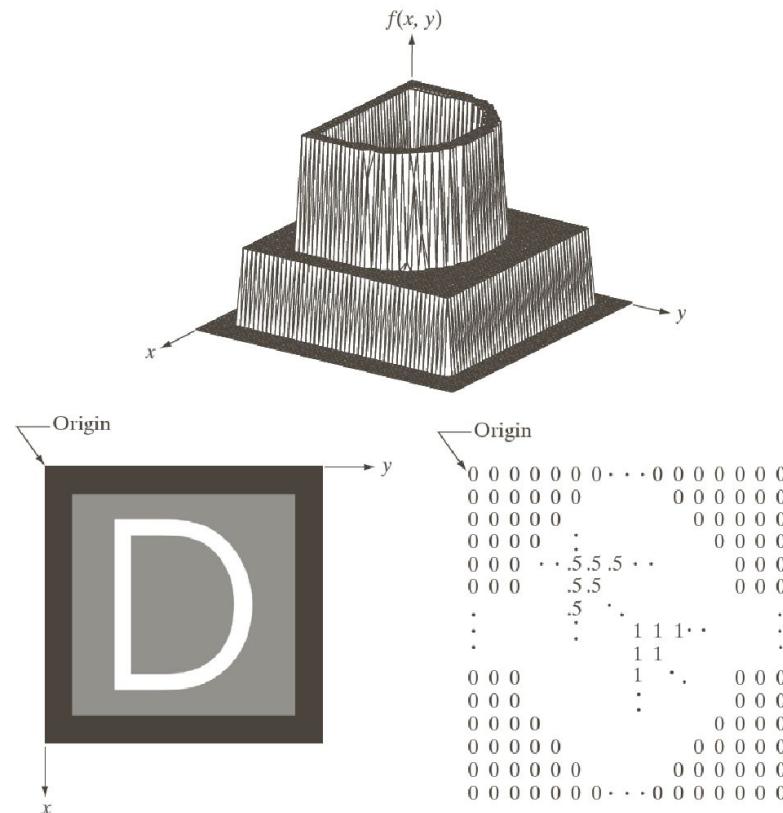


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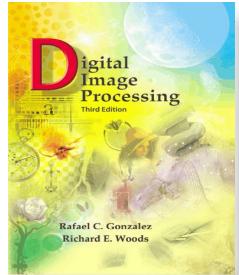
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a  
b c

**FIGURE 2.18**  
(a) Image plotted as a surface.  
(b) Image displayed as a visual intensity array.  
(c) Image shown as a 2-D numerical array (0, .5, and 1 represent black, gray, and white, respectively).



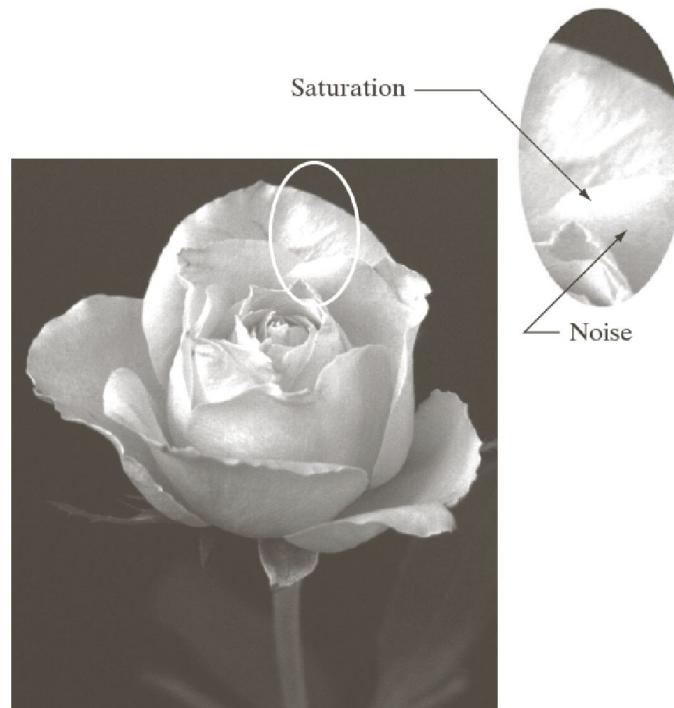
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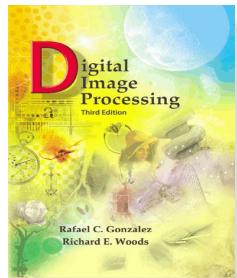
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**FIGURE 2.19** An image exhibiting saturation and noise. Saturation is the highest value beyond which all intensity levels are clipped (note how the entire saturated area has a high, *constant* intensity level). Noise in this case appears as a grainy texture pattern. Noise, especially in the darker regions of an image (e.g., the stem of the rose) masks the lowest detectable true intensity level.



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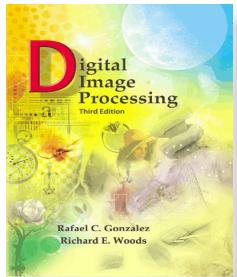
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**TABLE 2.1**

Number of storage bits for various values of  $N$  and  $k$ .

$N/k$	1 ( $L = 2$ )	2 ( $L = 4$ )	3 ( $L = 8$ )	4 ( $L = 16$ )	5 ( $L = 32$ )	6 ( $L = 64$ )	7 ( $L = 128$ )	8 ( $L = 256$ )
32	1,024	2,048	3,072	4,096	5,120	6,144	7,168	8,192
64	4,096	8,192	12,288	16,384	20,480	24,576	28,672	32,768
128	16,384	32,768	49,152	65,536	81,920	98,304	114,688	131,072
256	65,536	131,072	196,608	262,144	327,680	393,216	458,752	524,288
512	262,144	524,288	786,432	1,048,576	1,310,720	1,572,864	1,835,008	2,097,152
1024	1,048,576	2,097,152	3,145,728	4,194,304	5,242,880	6,291,456	7,340,032	8,388,608
2048	4,194,304	8,388,608	12,582,912	16,777,216	20,971,520	25,165,824	29,369,128	33,554,432
4096	16,777,216	33,554,432	50,331,648	67,108,864	83,886,080	100,663,296	117,440,512	134,217,728
8192	67,108,864	134,217,728	201,326,592	268,435,456	335,544,320	402,653,184	469,762,048	536,870,912



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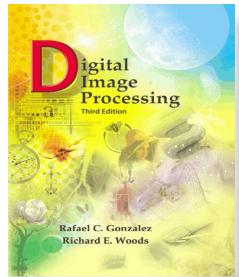
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**FIGURE 2.20** Typical effects of reducing spatial resolution. Images shown at: (a) 1250 dpi, (b) 300 dpi, (c) 150 dpi, and (d) 72 dpi. The thin black borders were added for clarity. They are not part of the data.

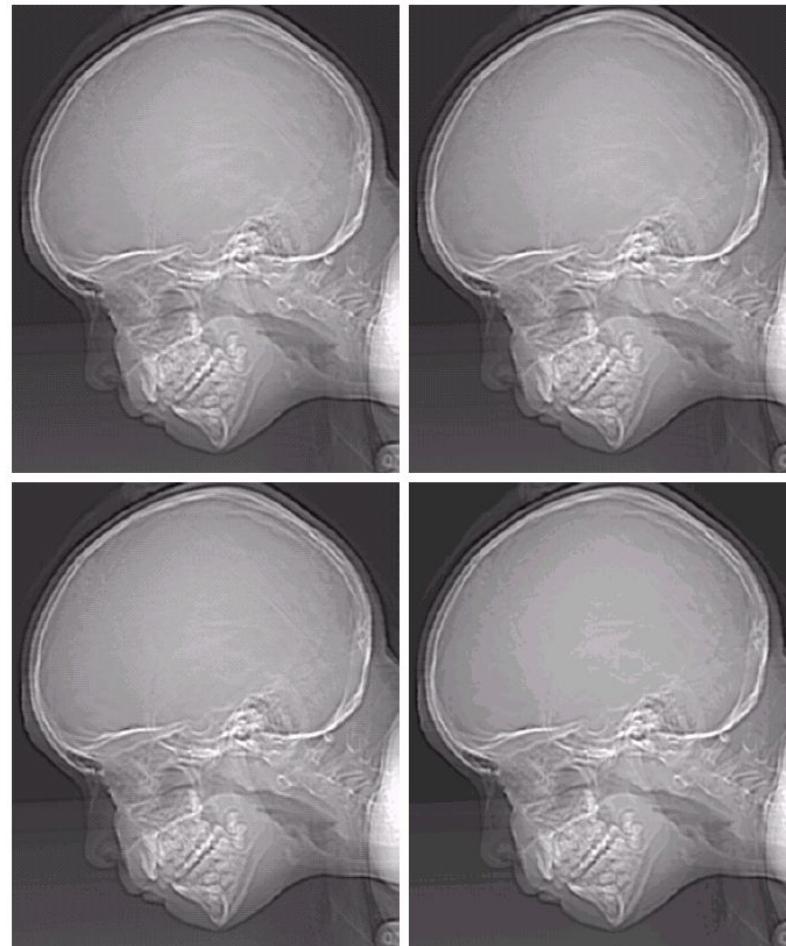


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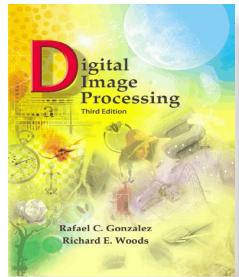
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a b  
c d

**FIGURE 2.21**  
(a)  $452 \times 374$ ,  
256-level image.  
(b)–(d) Image  
displayed in 128,  
64, and 32 gray  
levels, while  
keeping the  
spatial resolution  
constant.



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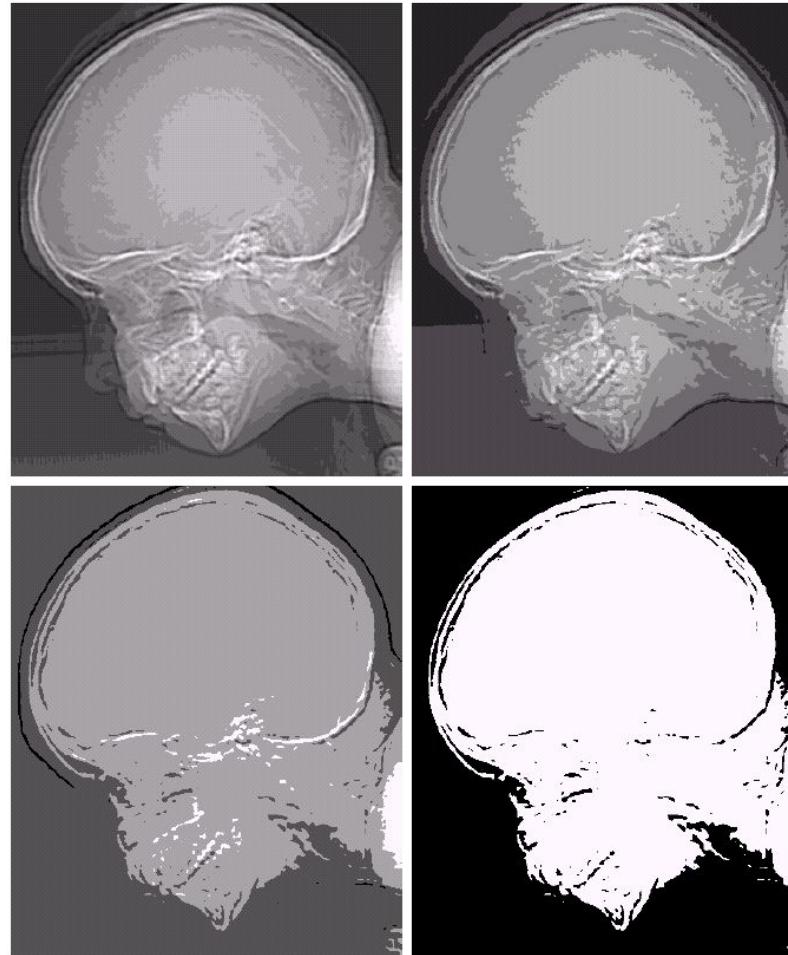
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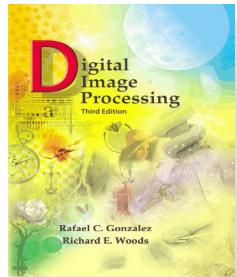
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e f  
g h

**FIGURE 2.21**  
*(Continued)*  
(e)–(h) Image displayed in 16, 8, 4, and 2 gray levels. (Original courtesy of Dr. David R. Pickens, Department of Radiology & Radiological Sciences, Vanderbilt University Medical Center.)





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a b c

**FIGURE 2.22** (a) Image with a low level of detail. (b) Image with a medium level of detail. (c) Image with a relatively large amount of detail. (Image (b) courtesy of the Massachusetts Institute of Technology.)