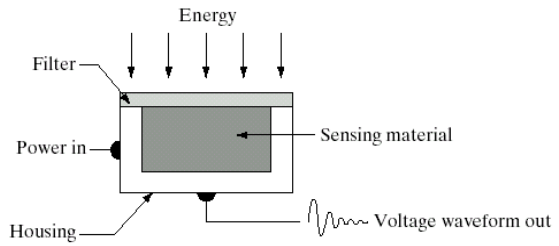
Digital Image formation

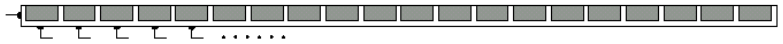
Interpolation

Image sensing and acquisition

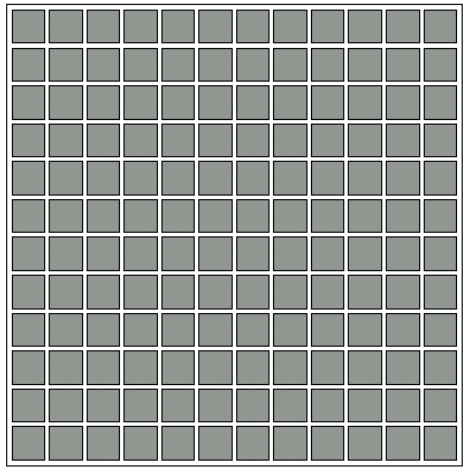
- Photoconvertor – energy into visible light



Single sensor



Line sensor



Array sensor

A simple image formation model

$f(x,y)$, $f>0$

The function f may represent intensity (for monochrome images) or color (for color images) or other associated values.

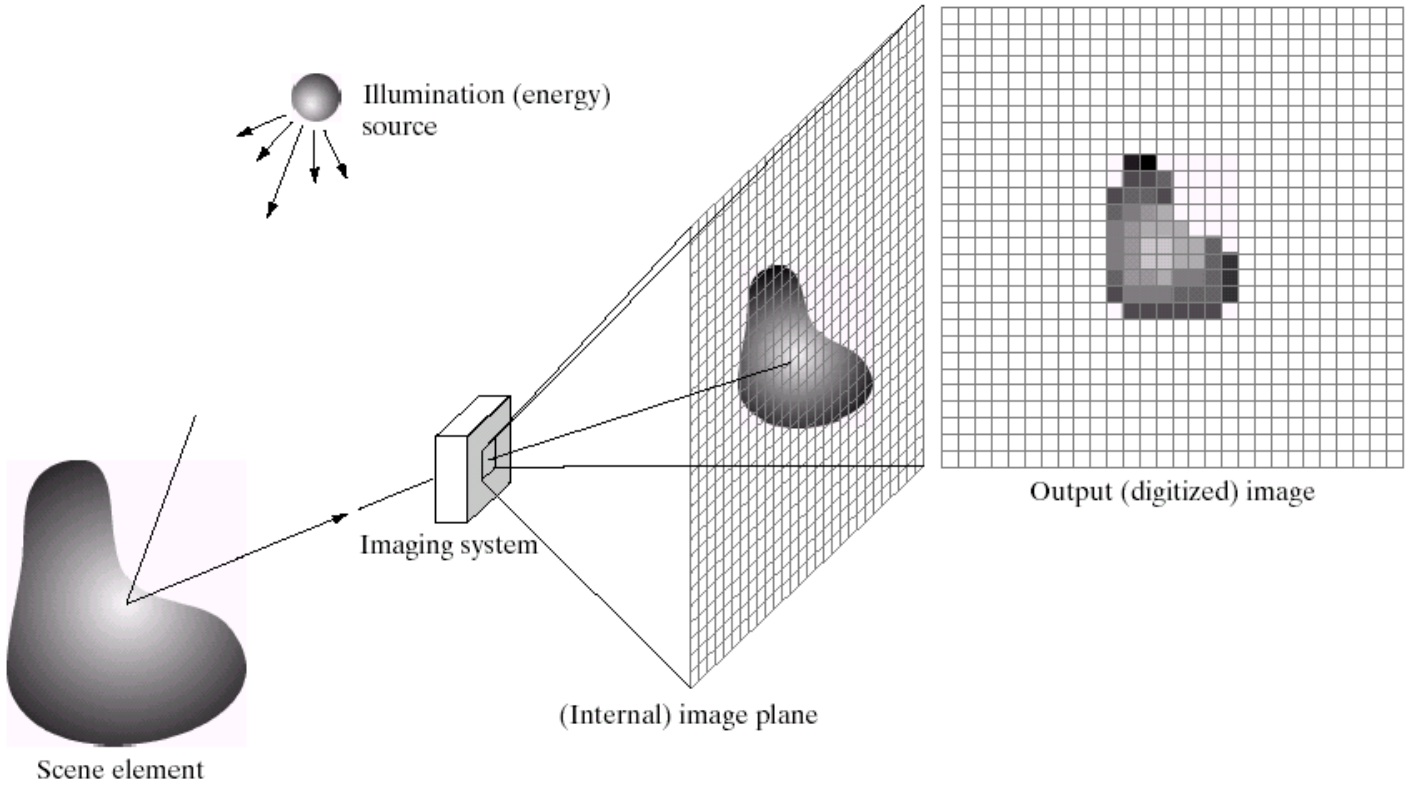
Intensity values are proportional to energy radiated by physical source

$0<f(x,y)<\infty$

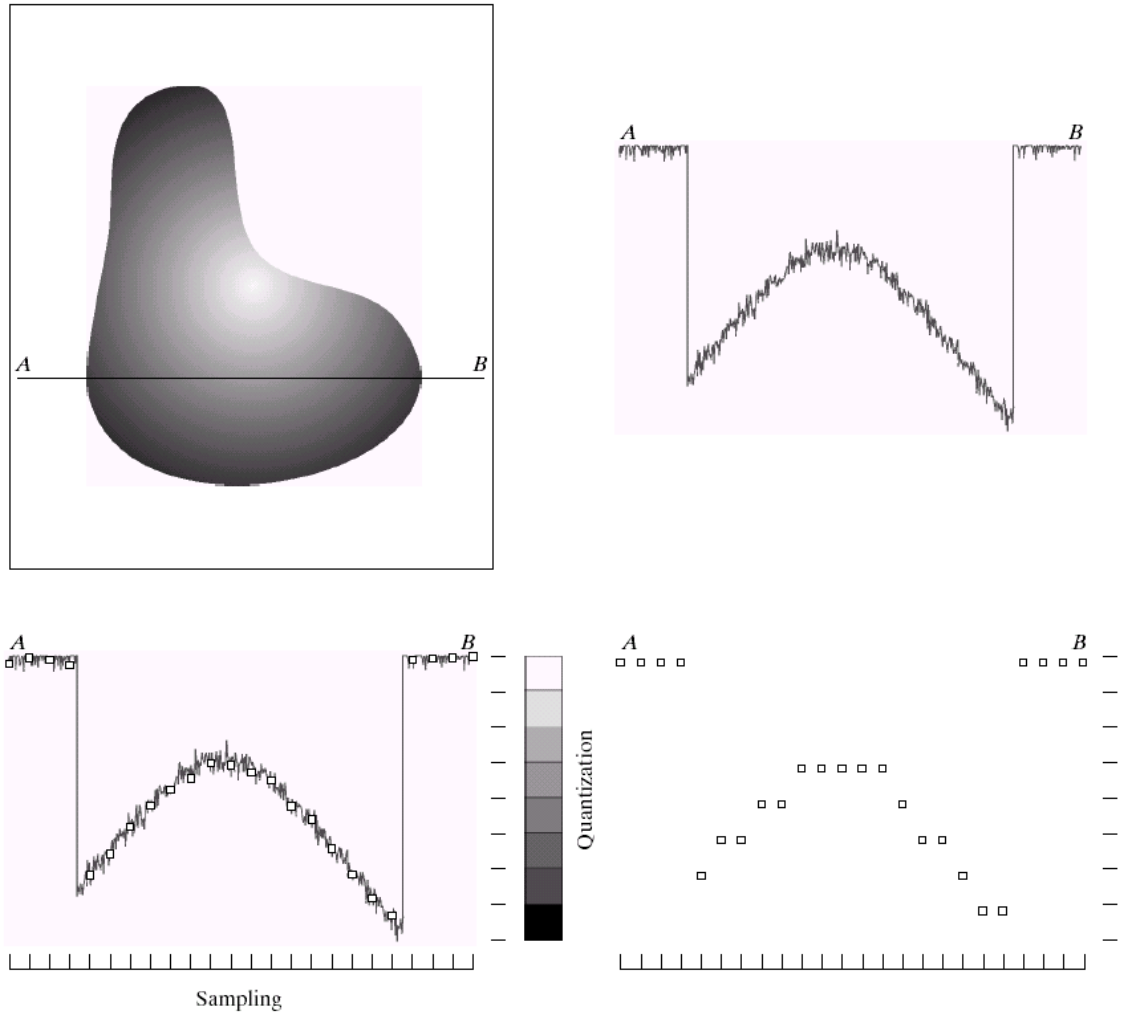
$f(x,y) = i(x,y)*r(x,y)$

$0<i(x,y)<\infty$ and $0<r(x,y)<1$

Digital image acquisition



Generating a digital image

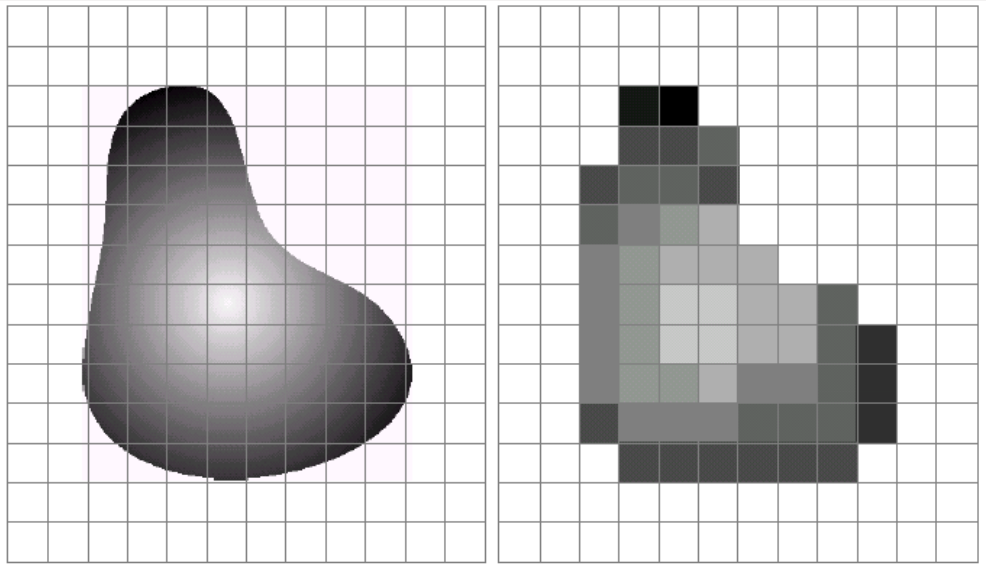


a b
c d

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.

Image sampling and quantization

- Sampling: Digitizing the coordinate values
- Quantization: Digitizing the amplitude values



a b

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

Spatial resolution / image resolution: pixel size or number of pixels

Representing digital images

f(s,t) : cont. image function of cont. variables s and t

Sample in 2-D array f(x,y) with M rows and N columns x = 0,1,…M-1

y=0,1,…N-1

f(0,0) : origin

Spatial domain

Spatial coordinates/spatial variables

Bits required to store a k-bit digitized image: b= k*M*N

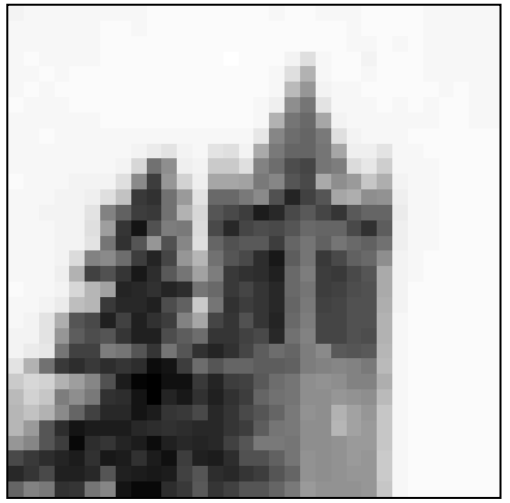
- Dynamic range: max measurable intensity (saturation level)/min detectable intensity (noise)
- Image contrast : diff in intensity between highest and lowest intensity levels in an image
- Spatial resolution: Smallest discernible detail in image
- Intensity resolution: Smallest discernible change in intensity levels
- False contouring: Very low intensity levels contribute in “Ridge” like structure

Effect of spatial resolution

256x256 pixels

128x128 pixels

64x64 pixels



32x32 pixels

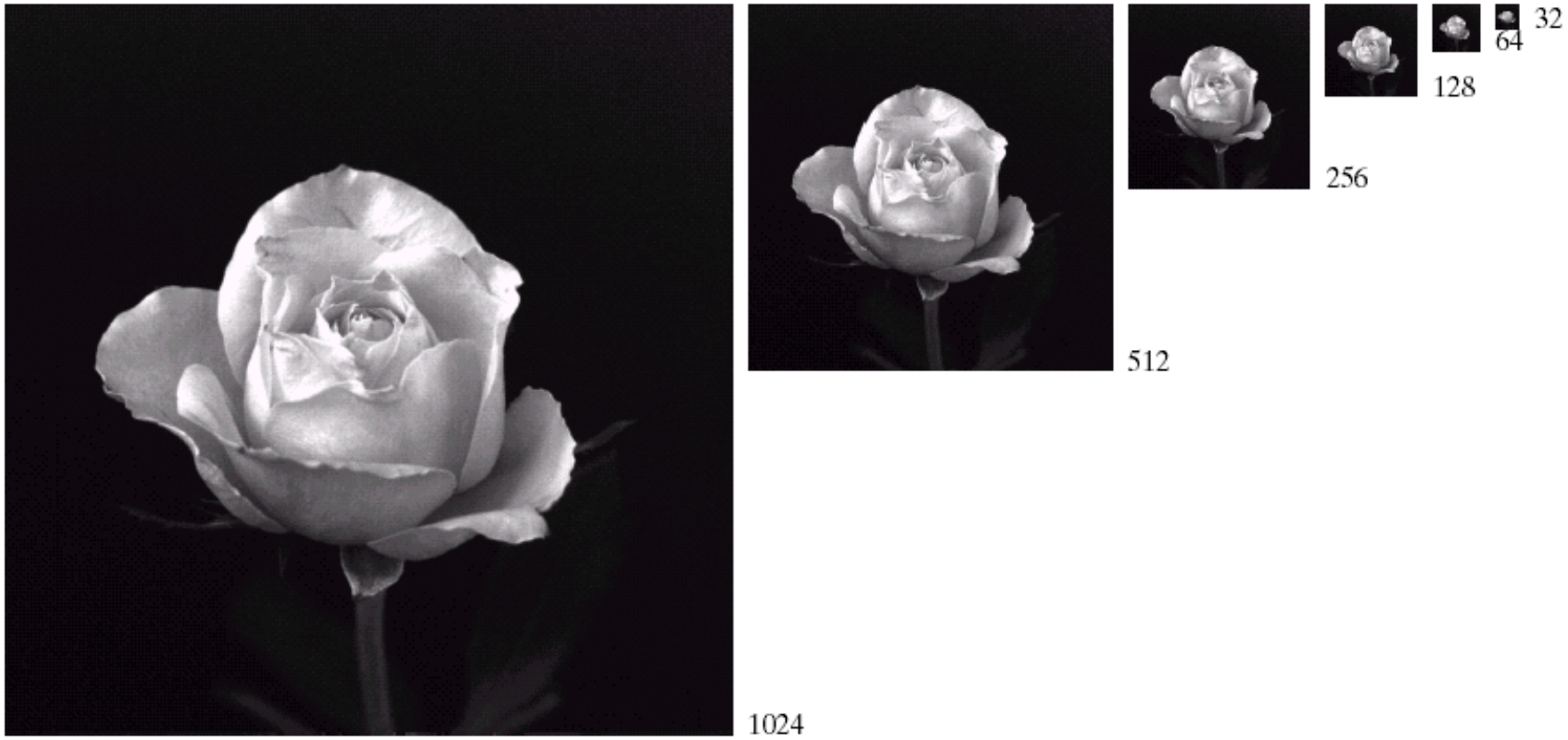


FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

Effect of spatial resolution

a b c
d e f

FIGURE 2.20 (a) 1024 × 1024, 8-bit image. (b) 512 × 512 image resampled into 1024 × 1024 pixels by row and column duplication. (c) through (f) 256 × 256, 128 × 128, 64 × 64, and 32 × 32 images resampled into 1024 × 1024 pixels.