

# Digital Image Processing Using MATLAB

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# *Light & Electromagnetic Spectrum*

$$\lambda = c / \nu$$

Where,

$\lambda$  is Wavelength in micro-meter or nano-meter range

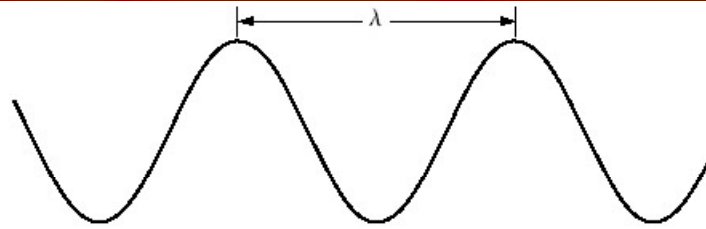
$C = 2.998 \text{ m/sec}$

$\nu$  = Frequency in Hertz

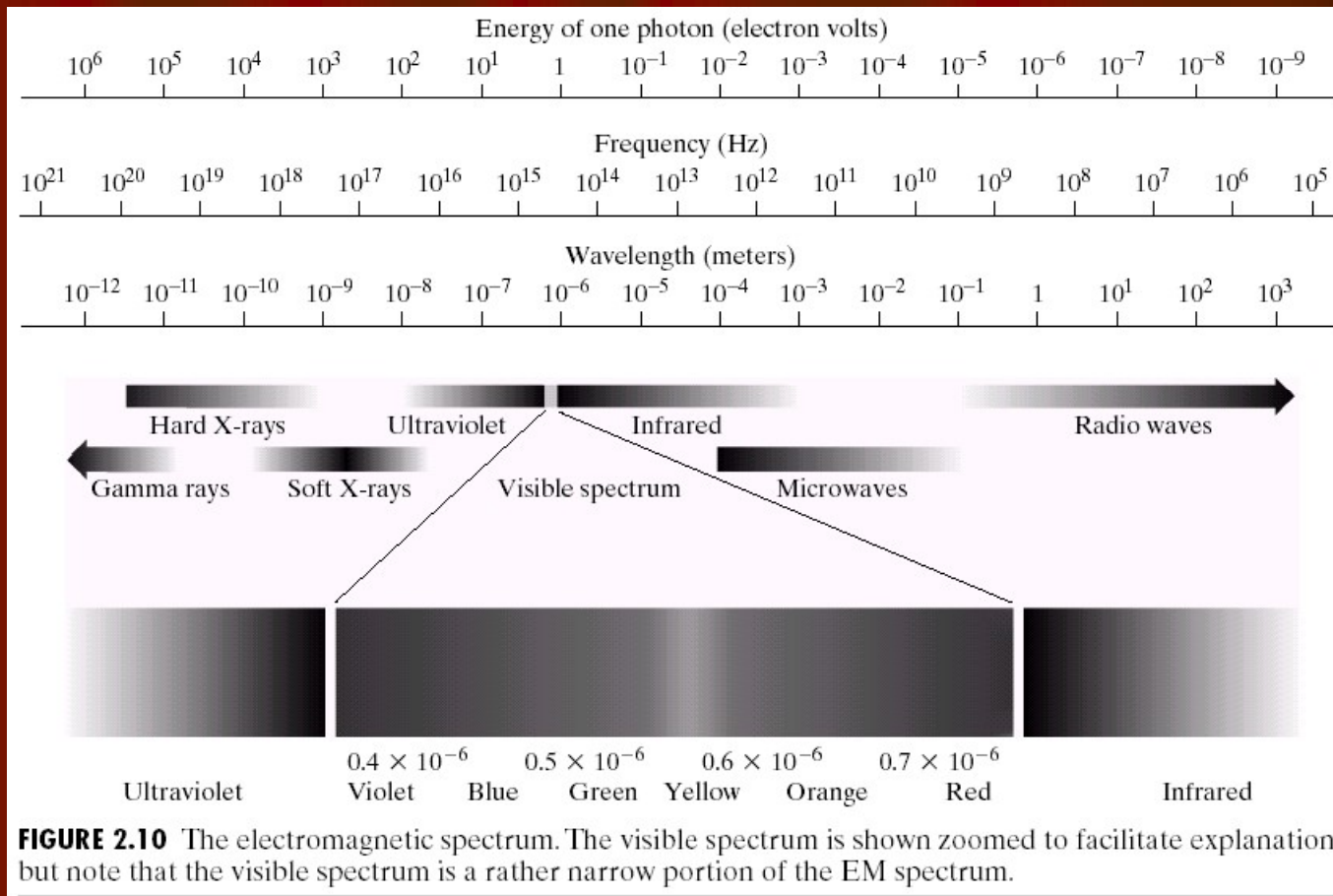
# *Light & Electromagnetic Spectrum*

**FIGURE 2.11**

Graphical  
representation of  
one wavelength.



# *Light & Electromagnetic Spectrum*



# *Light & Electromagnetic Spectrum*

$$E = h \nu$$

Where,

E is Energy in Electron volt

h = Planck's Constant

$\nu$  = Frequency in Hertz

## *Light & Electromagnetic Spectrum*

Colors that human perceive in an object are determined by the nature of the light reflected from that object

Light that is void of color is called monochromatic light i.e. gray-level or intensity.

Color (chromatic) light spans the electromagnetic energy spectrum from approximately 0.43 micro-meter to 0.79 micro-meter.

**Radiance, Luminance and Brightness are used to describe the quality of a color light source.**

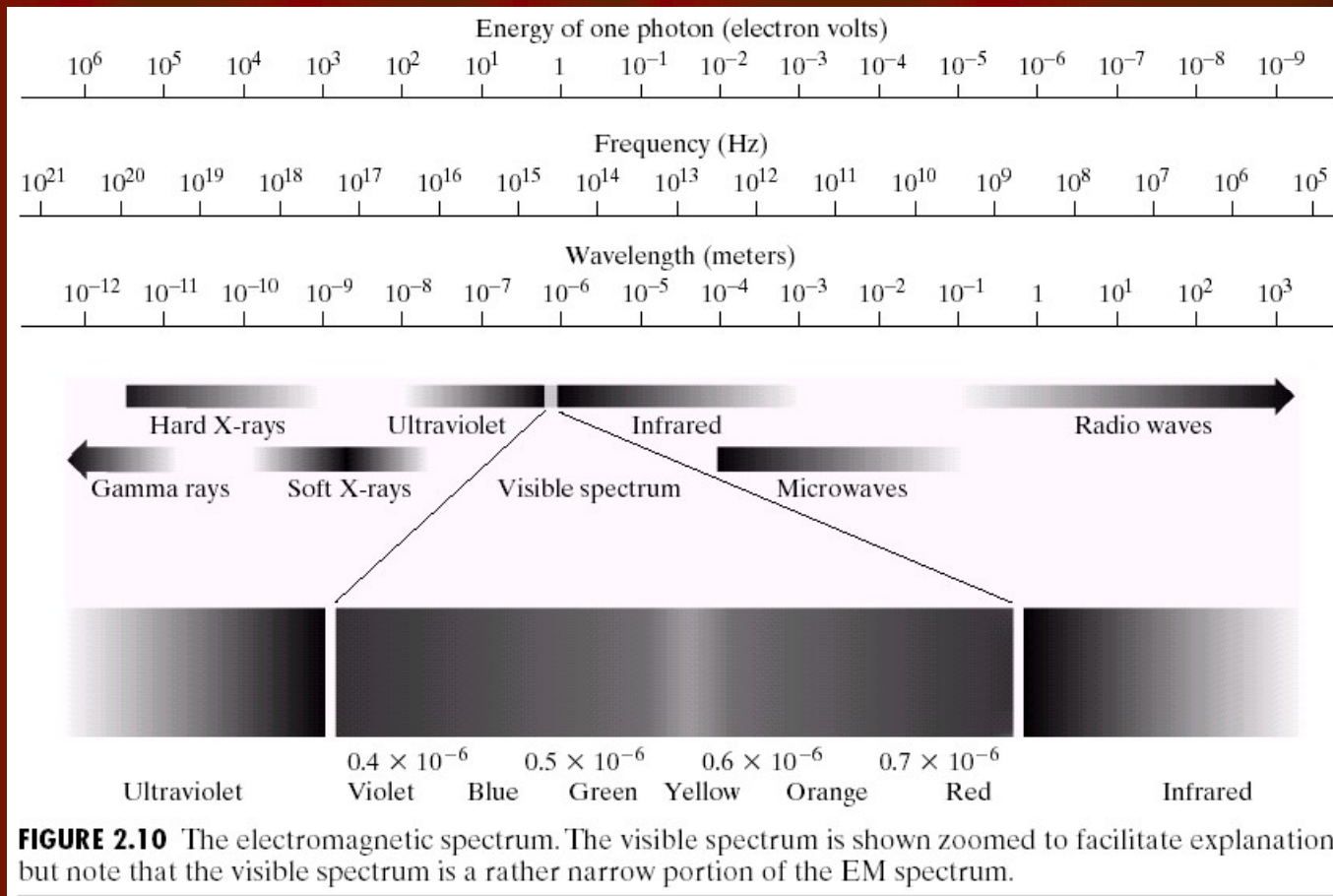
# *Light & Electromagnetic Spectrum*

Radiance is the total amount of energy that flows from the light source. It is measured in Watts

Luminance measured in lumens gives a measure of amount of energy an observer perceives from a light source.

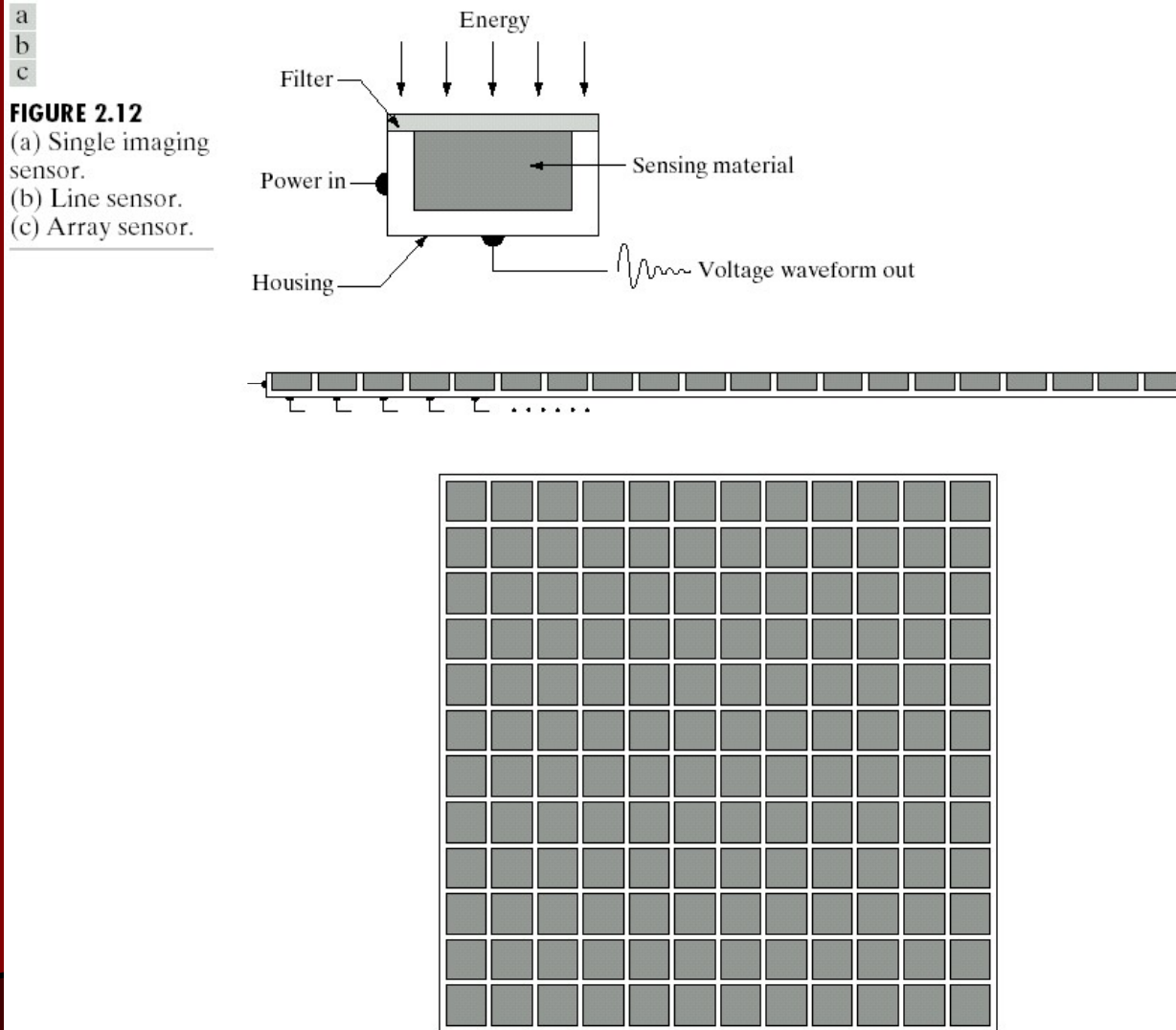
Brightness is a subjective descriptor of light perception.

# *Light & Electromagnetic Spectrum*

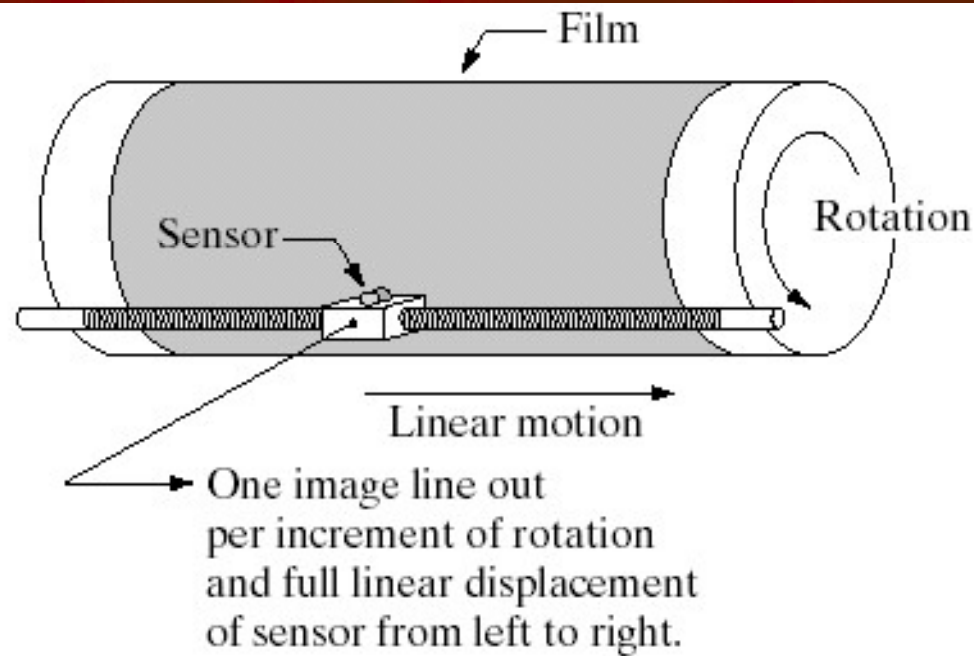




# *Light & Electromagnetic Spectrum*

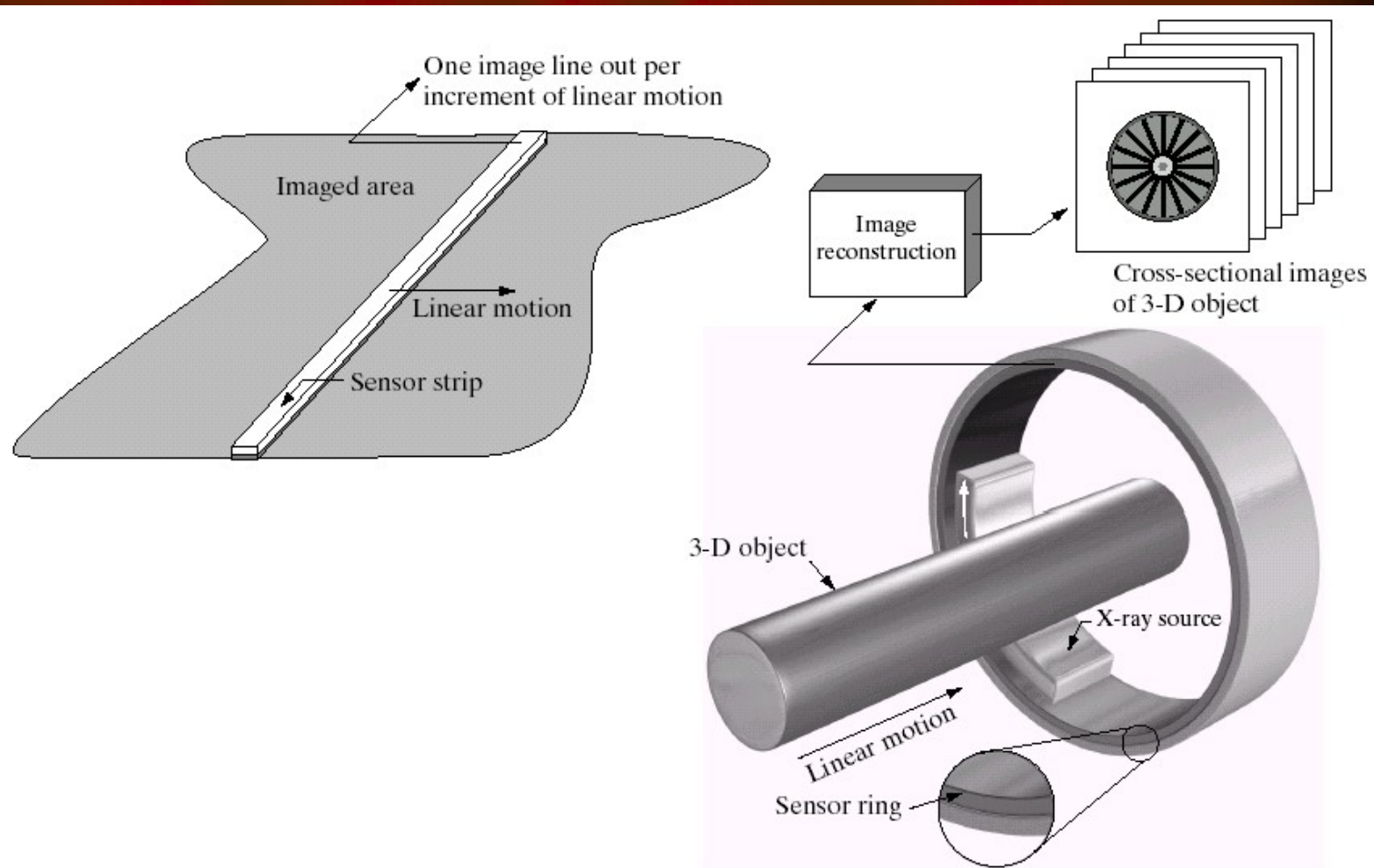


# *Light & Electromagnetic Spectrum*



**FIGURE 2.13** Combining a single sensor with motion to generate a 2-D image.

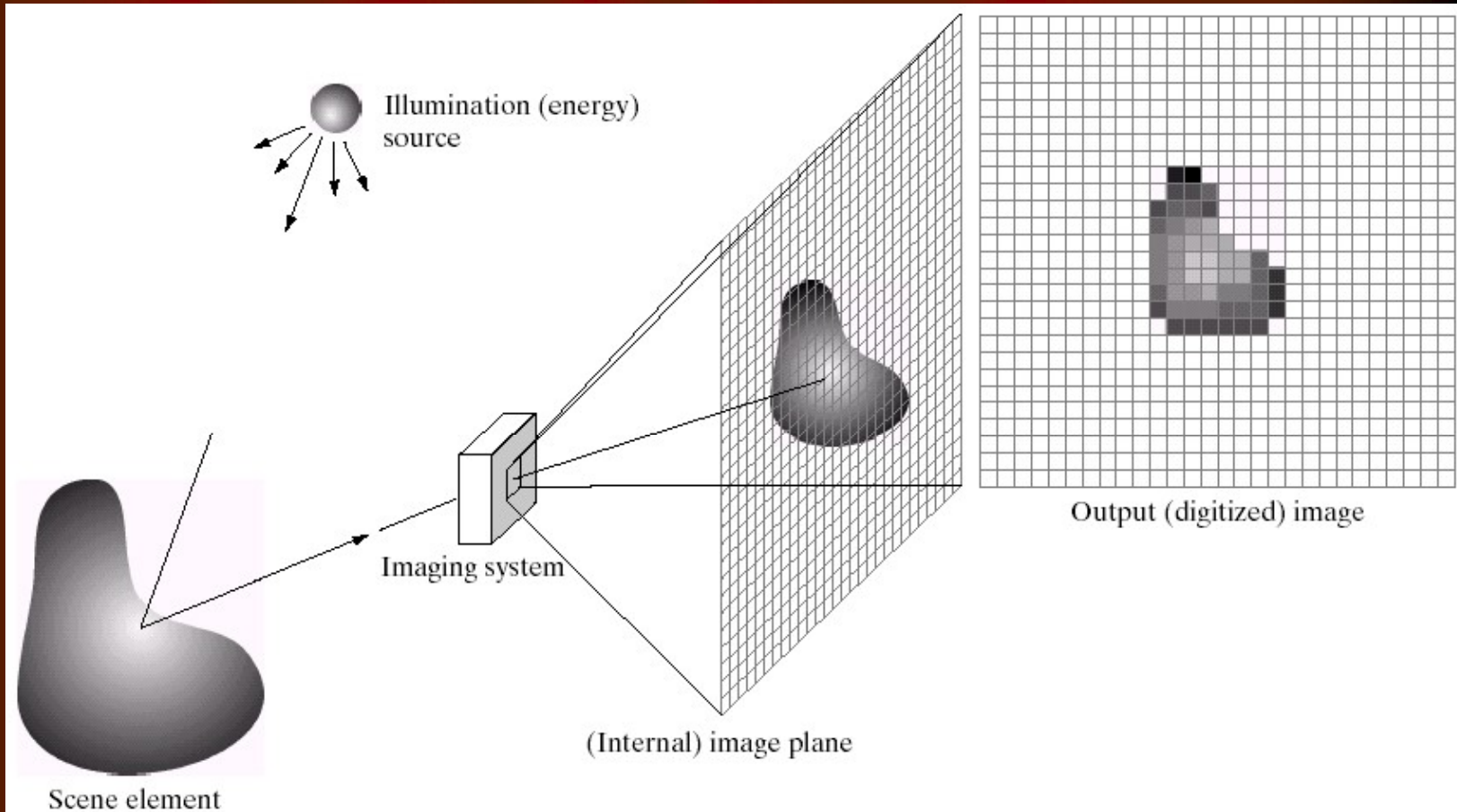
# *Light & Electromagnetic Spectrum*



a b

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

# *Image Acquisition Process*



a b c d e

**FIGURE 2.15** An example of the digital image acquisition process. (a) Energy (“illumination”) source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

# *Image Formation Model*

Monochrome image  $f(x, y)$  may be characterized by two components :

**Illumination:**  $i(x, y)$       **Reflectance:**  $r(x, y)$

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

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

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

$$0 < r(x, y) < 1$$

**Typical values of the illumination and reflectance:**

**Illumination:** sun on earth: 90,000 lm/m<sup>2</sup> on a sunny day; 10,000 lm/m<sup>2</sup> on a cloud day; moon on clear evening: 0.1 lm/m<sup>2</sup>; in a commercial office is about 1000 lm/m<sup>2</sup>

**Reflectance:** 0.01 for black velvet, 0.65 for stainless steel, 0.80 for flat-white wall paint, 0.90 for silver-plated metal, and 0.93 for snow

# Image Sampling and Quantization

- The output of most sensors is a continuous voltage waveform whose amplitude and spatial behavior are related to the physical phenomenon being sensed.
- To create a digital image, we need to convert the continuous sensed data into digital form. This involves two processes: *sampling* and *quantization*.

# Sampling and Quantization

- To convert it to digital form, we have to sample the function in both coordinates and in amplitude.
- Digitizing the coordinate values is called *sampling*.
- Digitizing the amplitude values is called *quantization*.

# Sampling and Quantization

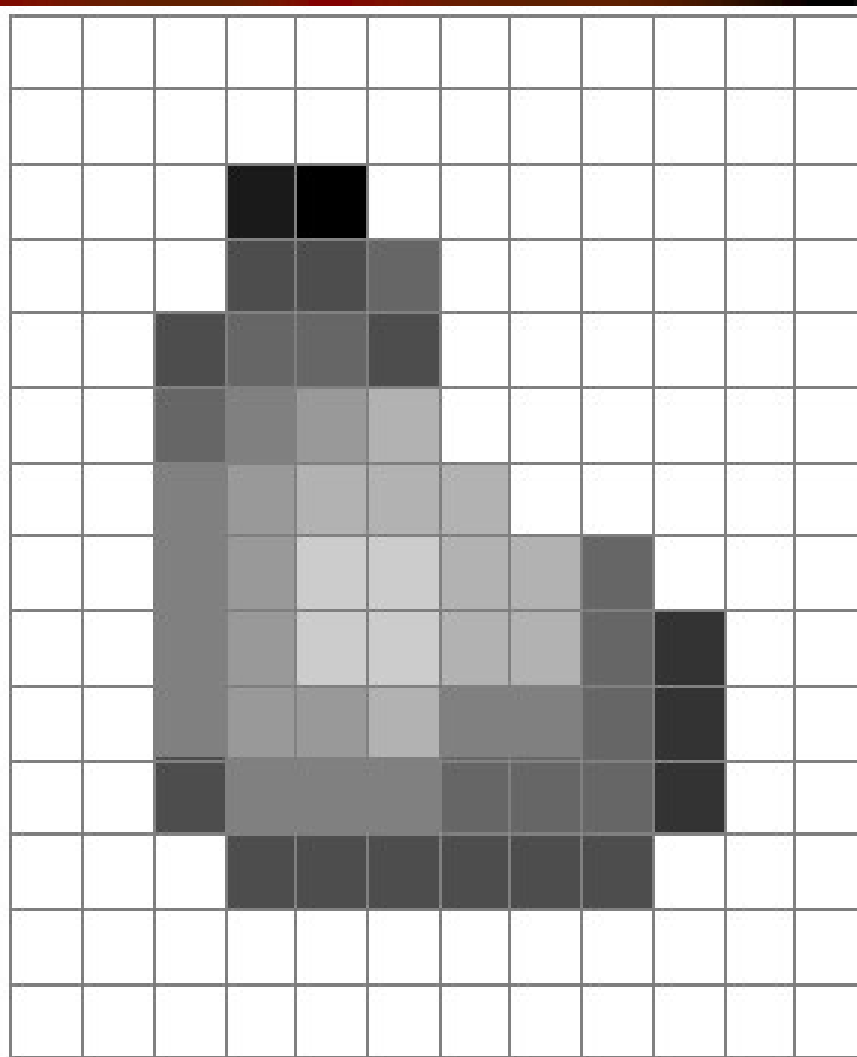
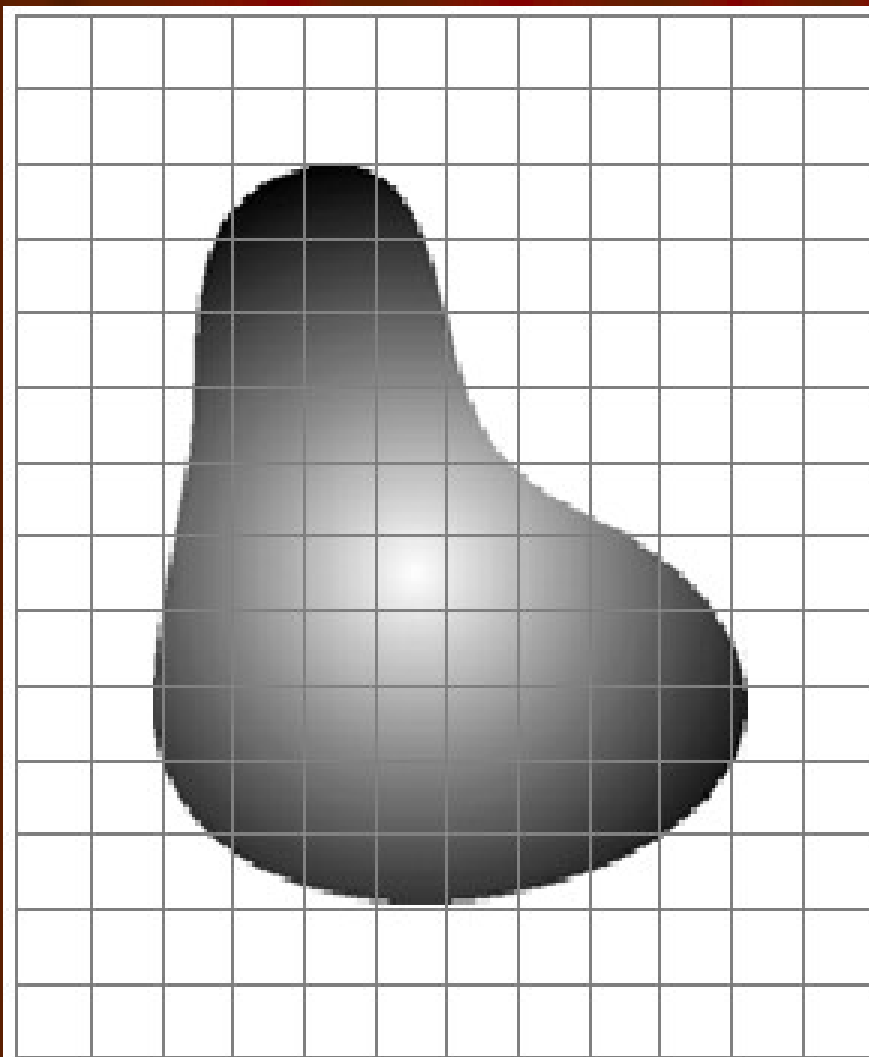
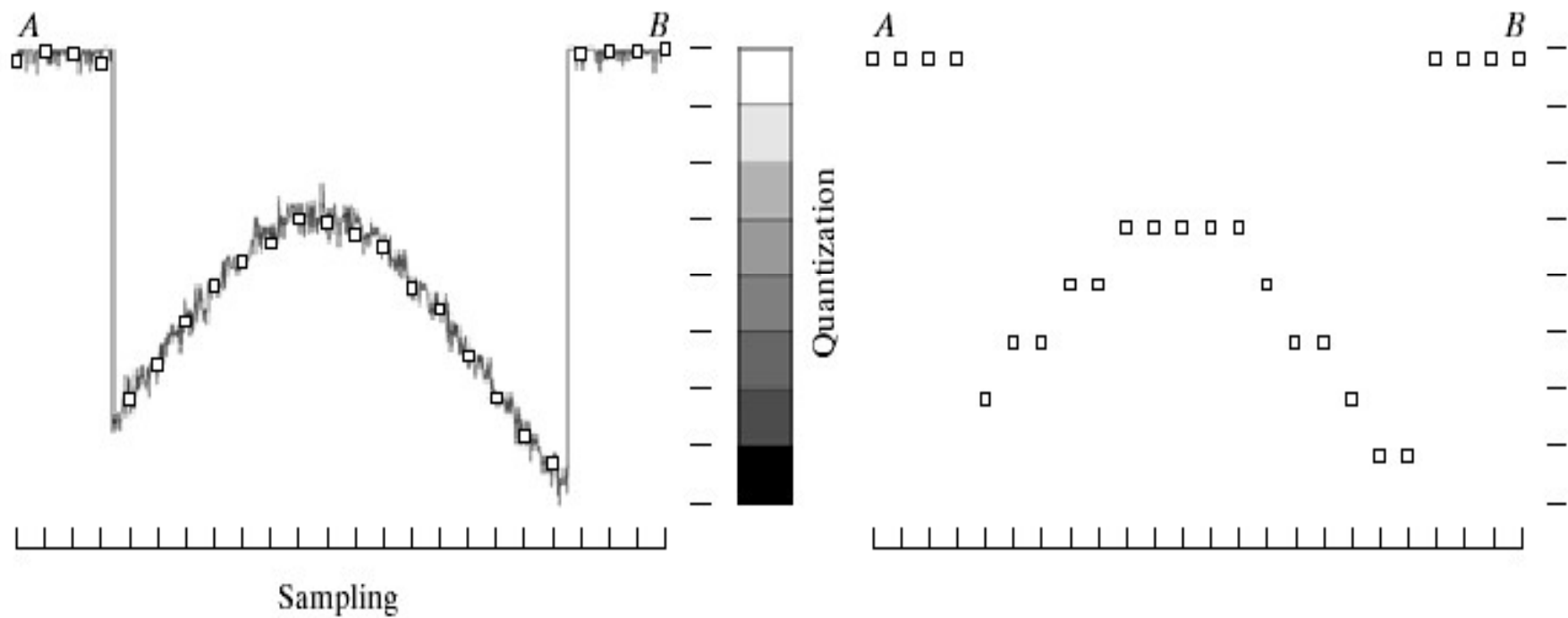


Image before sampling and quantization

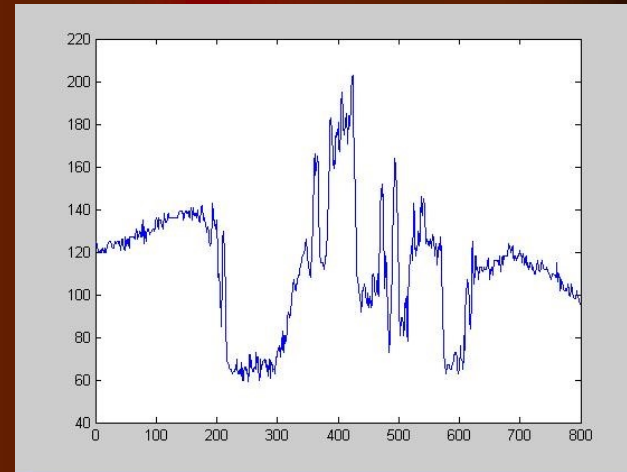
Result of sampling and quantization



# Sampling and Quantization



# Extract Scan line of a Gray Scale Image



```
A = imread( 'E:\Sunset_GrayScale', 'jpg');
```

```
Imshow (A);
```

```
[m , n] =size (A);
```

```
X= linspace(1,n,n);
```

```
Y= A(m/2, : );
```

```
Figure, plot( X, Y)
```

# Extract Red, Green & Blue plane of a Color Image



```
A = imread( 'E:\Sunset', 'jpg');
```

```
imshow (A);
```

```
[m , n, p] =size (A);
```

```
R=A(:, :, 1);
```

```
figure, imshow (R);
```

```
G=A(:, :, 2);
```

```
figure, imshow(G);
```

```
B=A(:, :, 3);
```

```
figure, imshow(B);
```