University of Al-Hamdaniya
Computer Science Department
Digital image processing


# Digital Image Processing An Introduction Cont.

## Lec-2

By

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# Image Sources

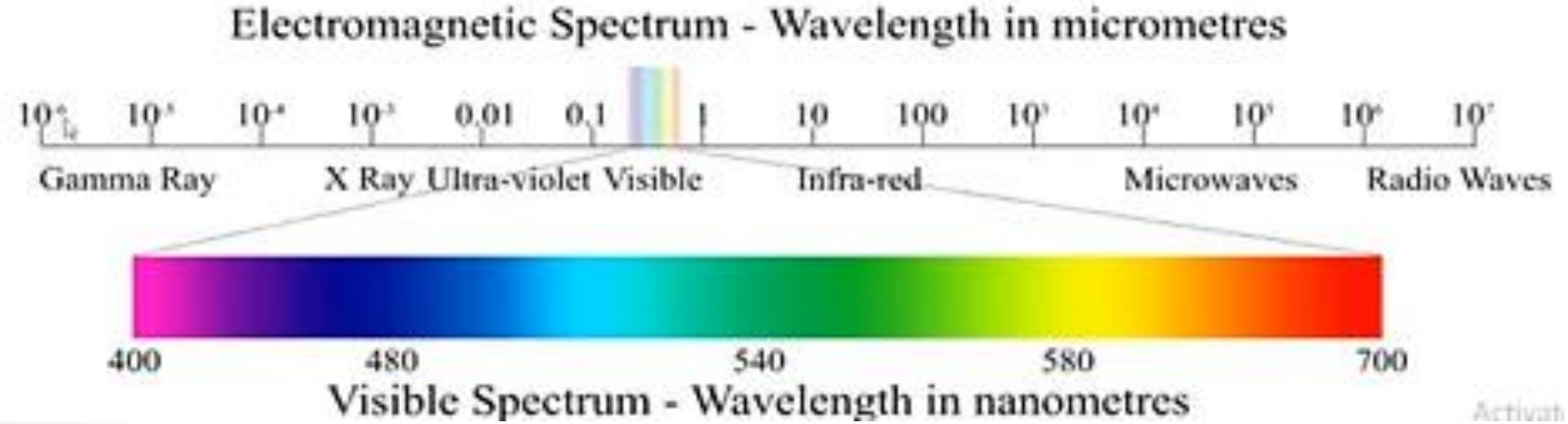
- Gamma-ray
  - Nuclear medicine, Astronomical observations
- X-ray
  - Medical diagnostics, Astronomy and other industries
- ultra-violet
  - Lithography, industrial inspection, microscopy, lasers, biological imaging

# Image Sources

- Infrared
  - Remote sensing, night vision
- Microwave
  - radar,
- Radio
  - Medicine (MRI), astronomy

# Image Sources

- Visible light spectrum



# Image Sources

- Image can also be generated by
  - Sound
    - Geological exploration – hundreds of Hz
    - Medicine – millions of Hz (ultrasound)
  - Electron microscopy
    - Electron microscope – slight projector-like

# Image Formation Model

- Image generated from a physical process will have its values proportional to the energy radiated by the physical source (e.g. electromagnetic waves).
- Hence, $f(x,y)$ must be nonzero and finite; or

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

- $f(x,y)$ may be characterized by two components

  (1) Illumination – $i(x,y)$

  (2) reflectance – $r(x,y)$

# Image Formation Model

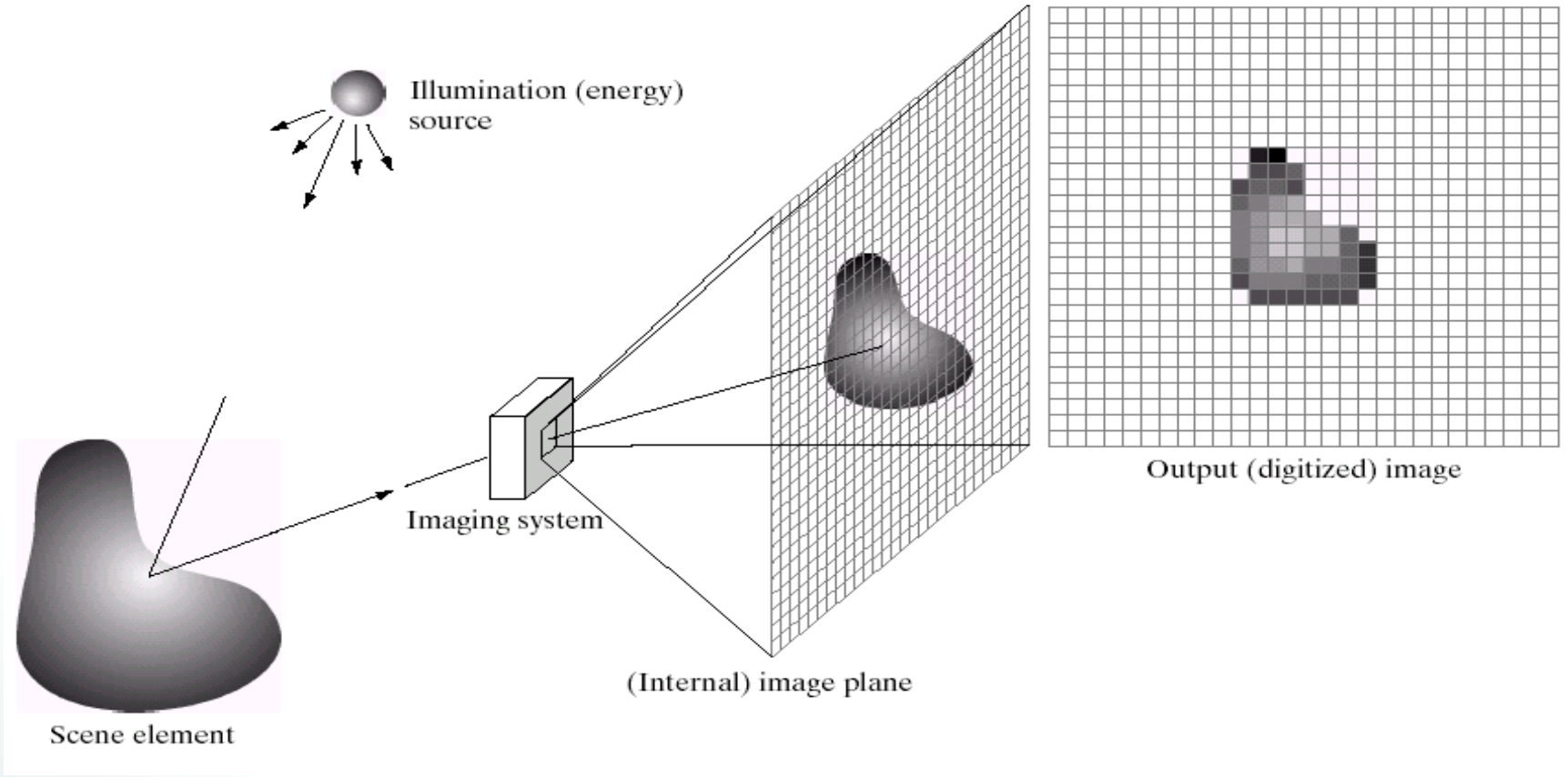
- Thus, we can write $f(x,y)$ as:

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

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

- Note:
  - Reflectance is bounded by zero (total absorption) and 1 (total reflection). Eg. 0.65 for stainless steel, 0.90 for silver-plated metal, and 0.93 for snow.
  - Illumination is determined by the source eg. on clear day – 90,000 lm/m$^2$, on cloudy day – 10,000 lm/m$^2$ and full moon – 0.1 lm/m$^2$. Normal office – 1000 lm/m$^2$.

# Image Formation Model



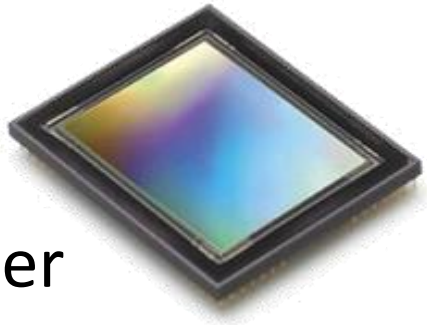
# Digitization

- A process to convert an image to 2D digital array representing the image.
- Digital image consists of numbers in 2D array.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 220 | 233 | 245 | 226 | 122 | 96 | 91 | 88 | 81 | 77 |
| 221 | 231 | 243 | 228 | 133 | 96 | 89 | 89 | 81 | 75 |
| 223 | 229 | 240 | 231 | 147 | 98 | 88 | 90 | 81 | 75 |
| 224 | 226 | 237 | 235 | 167 | 104 | 89 | 91 | 82 | 75 |
| 225 | 224 | 234 | 239 | 188 | 110 | 89 | 89 | 83 | 76 |
| 226 | 224 | 232 | 242 | 207 | 115 | 88 | 88 | 83 | 78 |
| 226 | 221 | 231 | 244 | 223 | 123 | 89 | 86 | 83 | 80 |

# Digitization

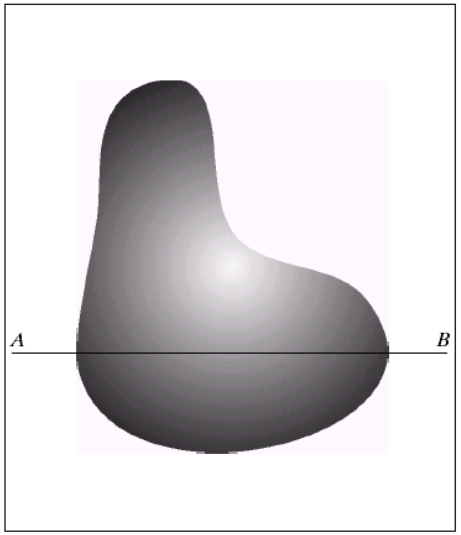
- Involve 2 processes
  - Sampling – placing the pixels on the x-y coordinates/grid. Also known as the spatial resolution.
  - Quantization – assigning values to the pixels according to the color map being used. Also known as the depth or color resolution.
- Two modes
  - Line scanner – flatbed scanner
  - Array scanner – CCD & CMOS camera

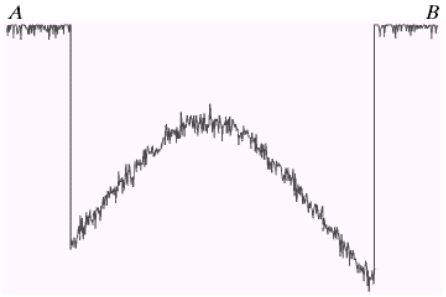


# Sampling and Quantization

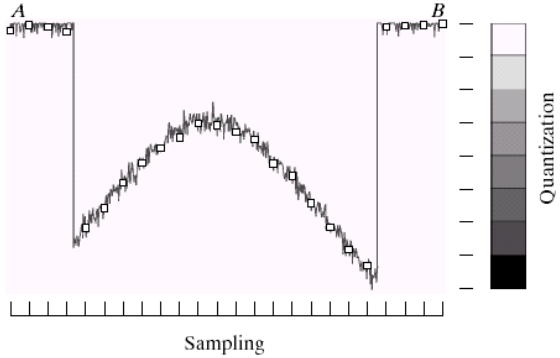
- Line scanner

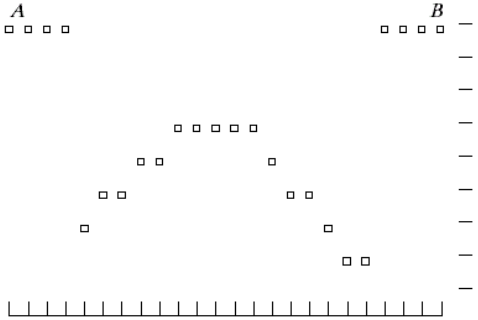
| | |
|---|---|
| (a) | (b) |
| (c) | (d) |




(a)Continuous Image
(b) A scan line from A to B
(c) Sampling and quantization
(d) Digital scan line.

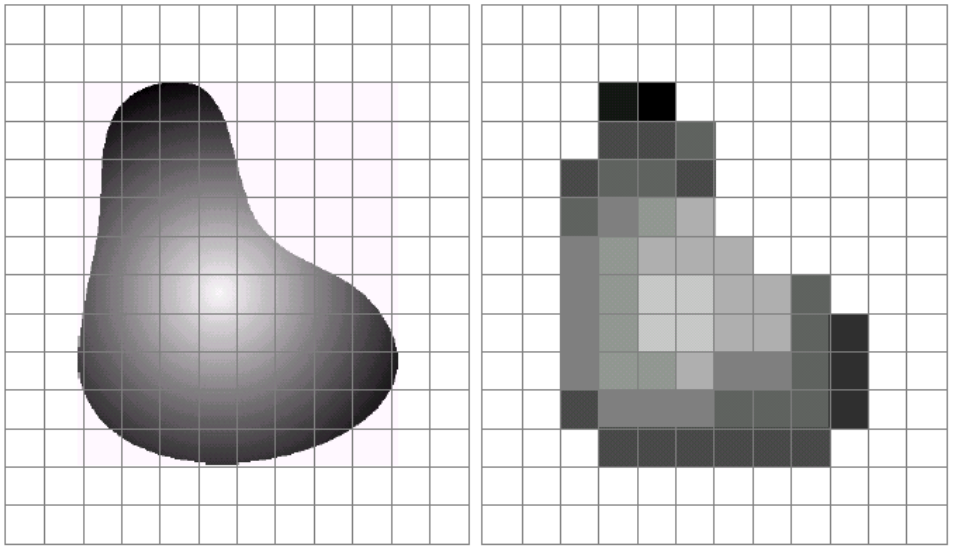


# Sampling and Quantization

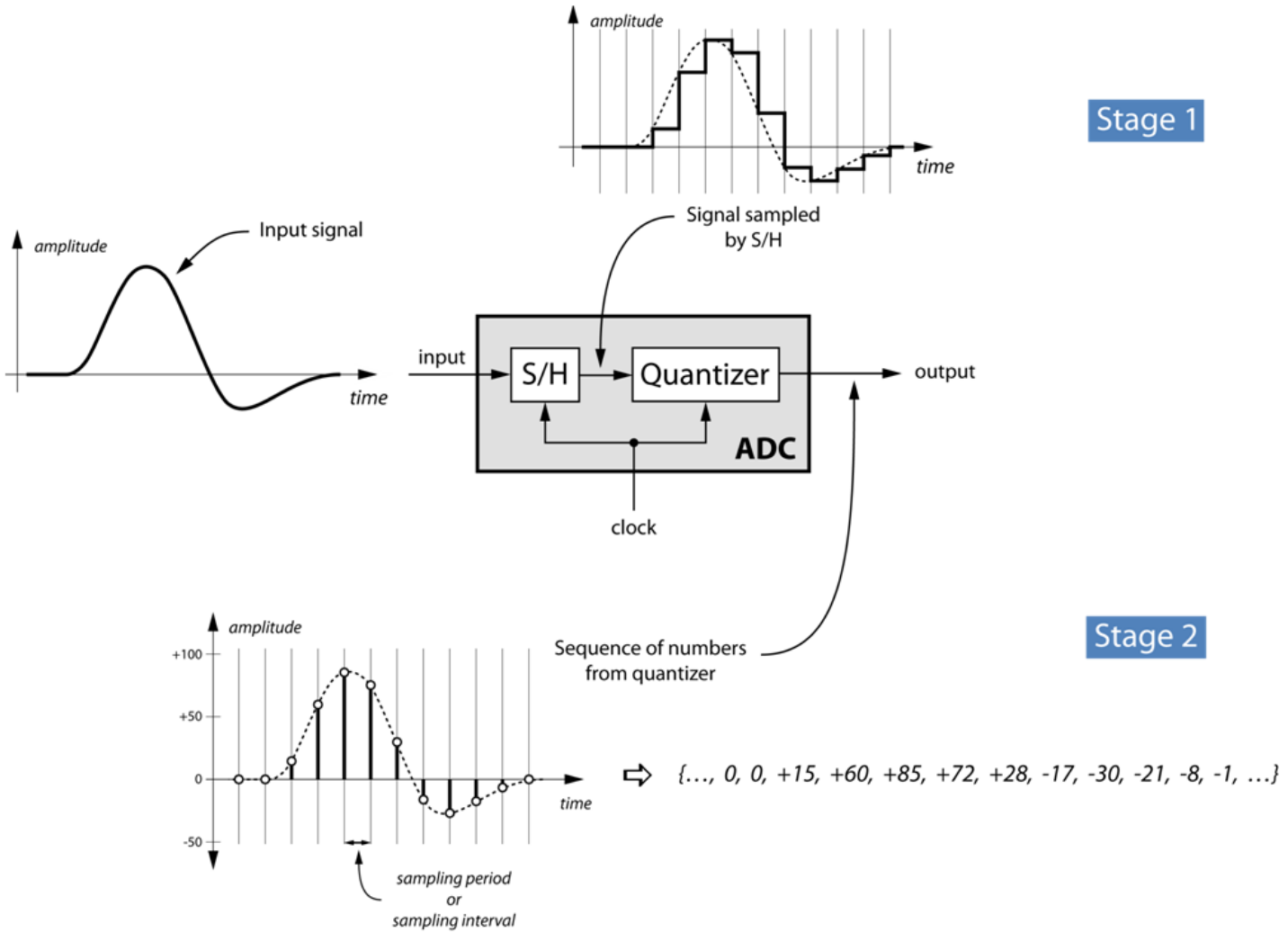
- Array scanner

| (a) | (b) |
|---|---|



(a)Continuous Image projection onto a sensor array.
(b) Result of image sampling and quantization.

# Sampling and Quantization



# End Of Lecture