SLIIT

Discover Your Future

IT4130 – Image Understanding and Processing

Lecture 02 – Image Digitization Process

Image digitization

- Why do we need digitization ?
- What is digitization ?
- How to digitize an image ?

Image Acquisition Process

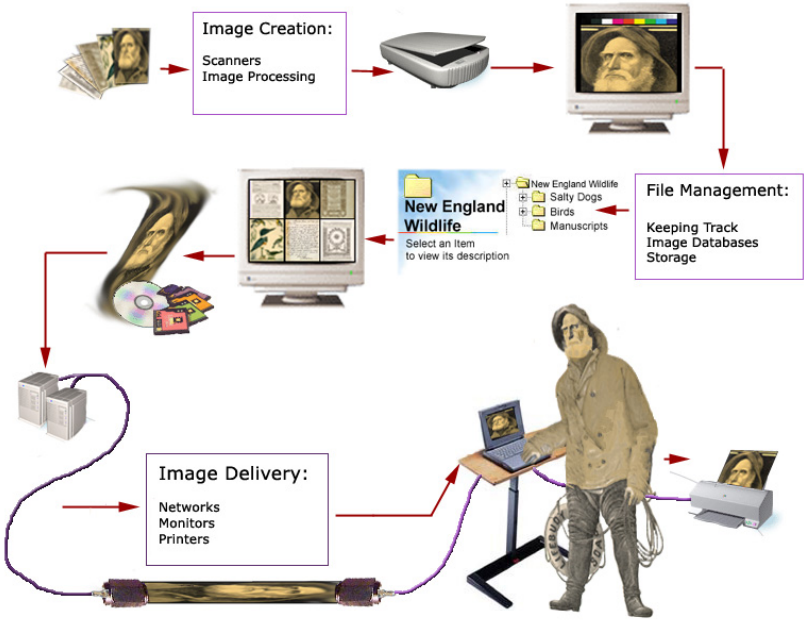
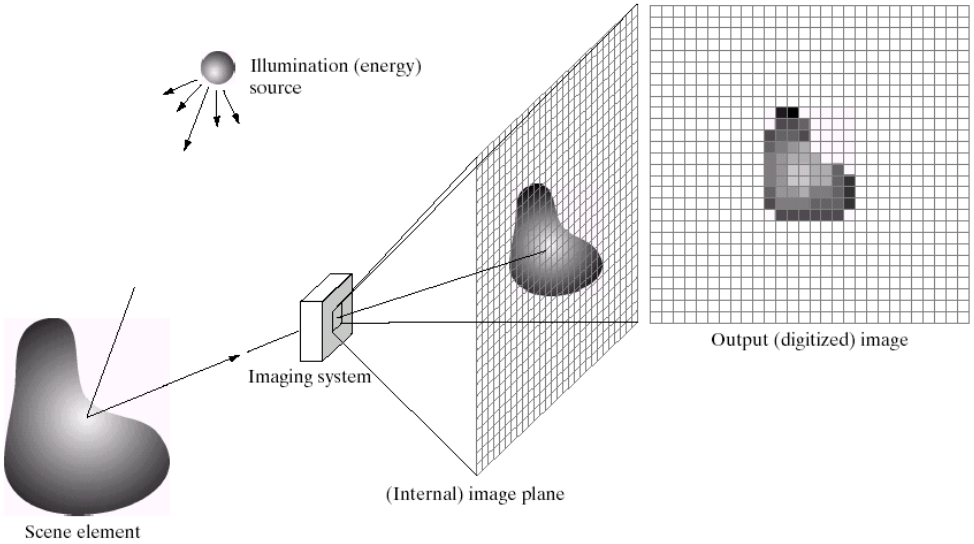


Image Acquisition Process



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.

Why Digitization

$0 \le x \le H$

$0 \le y \le L$

$f(x,y)$ $\quad I_{min} \le f(x,y) \le I_{max}$

$= r(x,y) \cdot i(x,y)$

Why Digitization

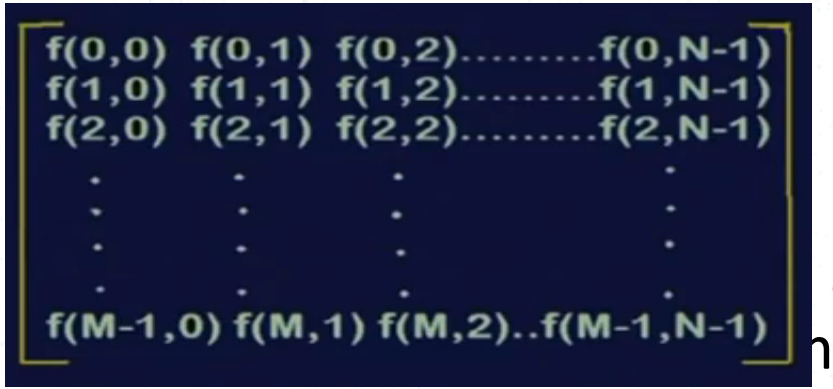
Theory of Real Numbers: Between any two given point there are infinite number of points

- An image should be represented by infinite numbers of points
- Each such image point may contain one of the infinitely many possible intensity/color values needing infinite number of bits

Obviously such a representation is not possible in any digital computer !!

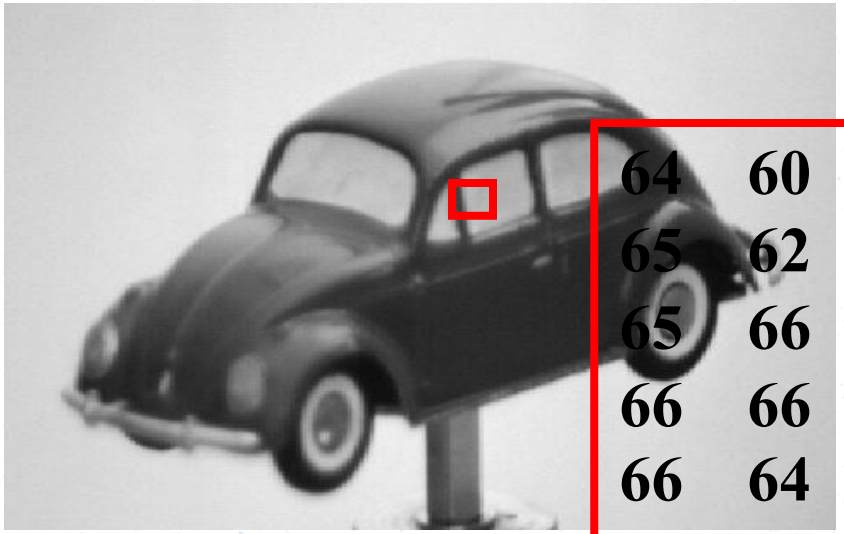
What is desired

- An image to be represented in the form of a finite 2D matrix



- Each of the ne one of finite discrete values

Image as a Matrix of Numbers



64	60	69	100	149	151	176	182	179
65	62	68	97	145	148	175	183	181
65	66	70	95	142	146	176	185	184
66	66	68	90	135	140	172	184	184
66	64	64	84	129	134	168	181	182
59	63	62	88	130	128	166	185	180
60	62	60	85	127	125	163	183	178
62	62	58	81	122	120	160	181	176

What is Digitization

- Image representation by 2D finite matrix – Sampling
- Each matrix element represented by one of the finite set of discrete values - Quantization

Sampling, Quantization and Display

- Computer processing of images require that images be available in digital form

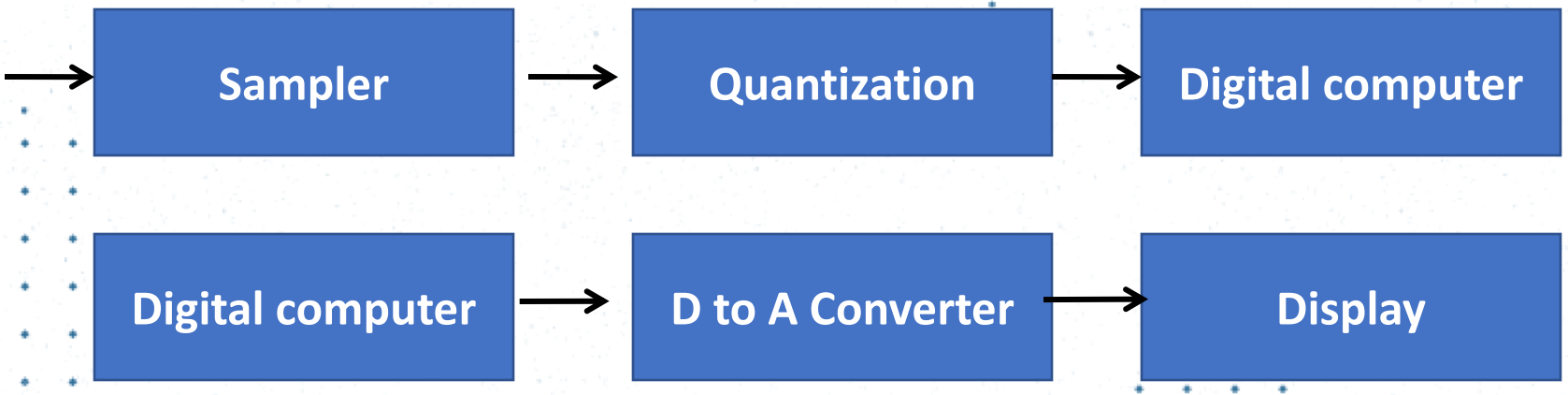
- Digitization includes:

(a) Sampling

(b) Quantization

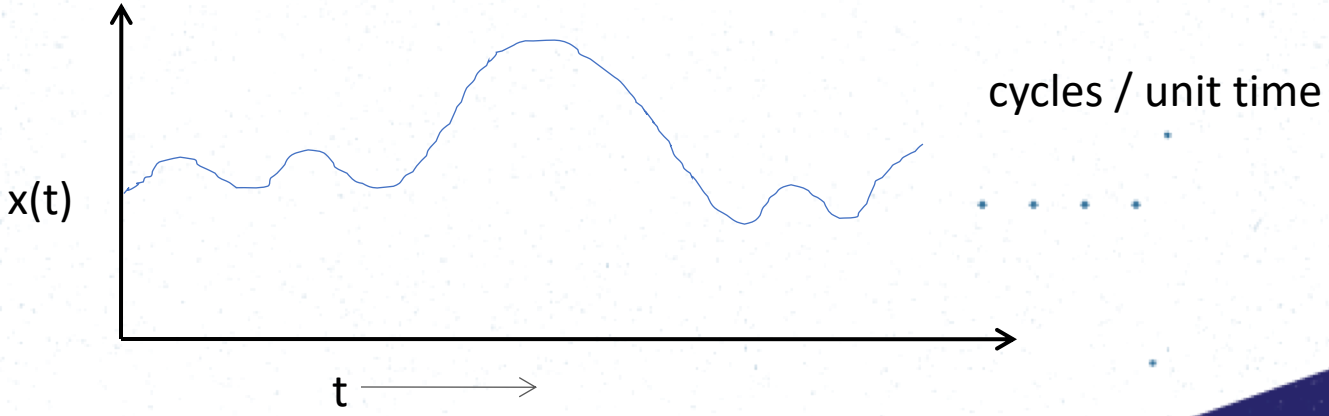
- To display images it is first converted to analog signal which is scanned onto a display

Sampling, Quantization and Display



Sampling

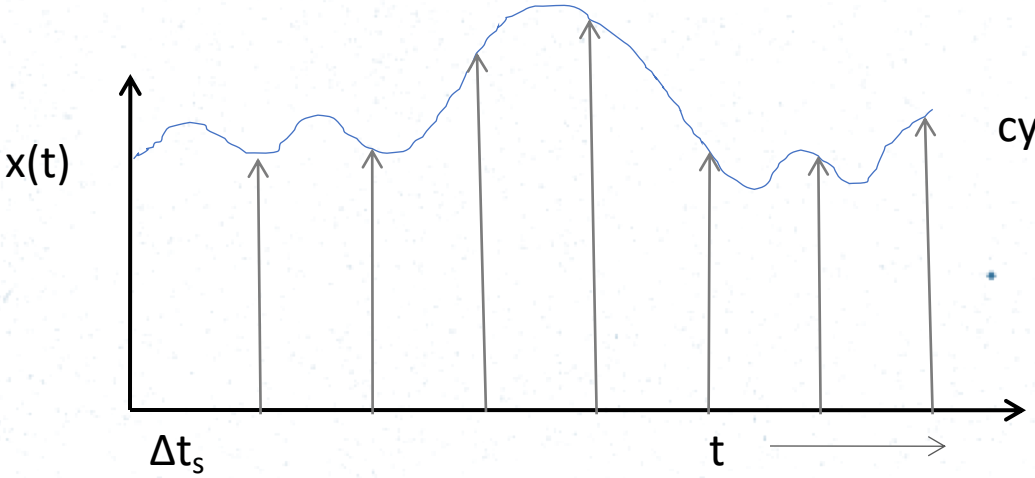
- 1D sampling



Sampling

- 1D sampling

Sampling Frequency $f_s = \frac{1}{\Delta t_s}$

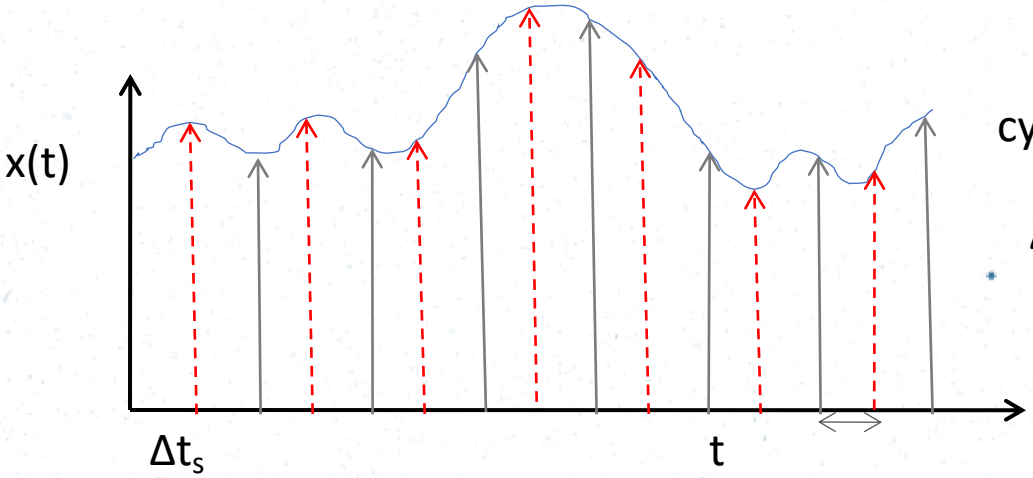


cycles / unit time

Sampling

- 1D sampling

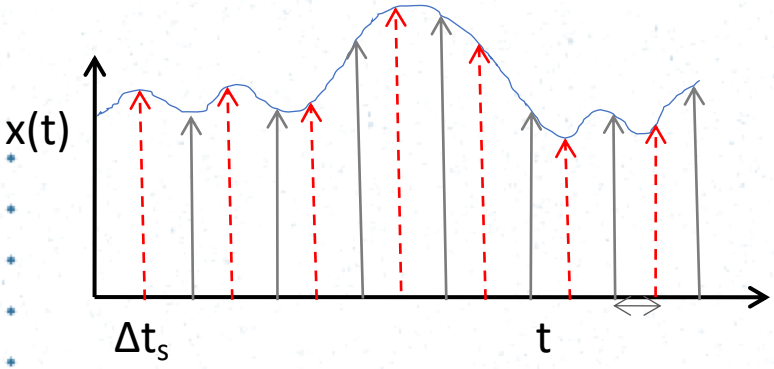
Sampling Frequency $f'_s = \frac{1}{\Delta t'_s} = \frac{2}{\Delta t_s} = 2fs$

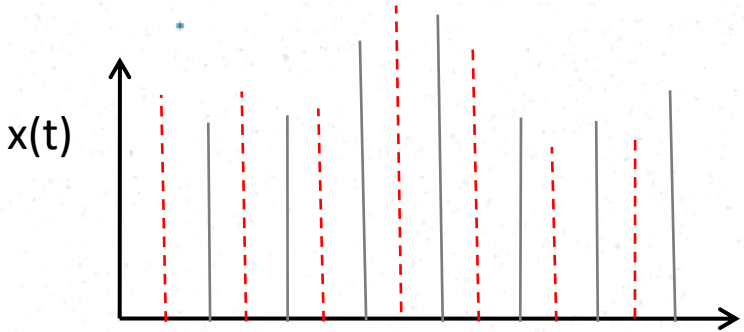


cycles / unit time

$\Delta t'_s = \frac{\Delta t_s}{2}$

Sampling





Quantization

- Quantization is a mapping of a continuous variable U to a discrete variable U’

$U' \in \{ r_1, r_2, r_3, \ldots\ldots\ldots\ldots r_L \}$

Quantization

- Mapping a generally a staircase function.

Quantization Rule:

- Define a set of decision or transition levels

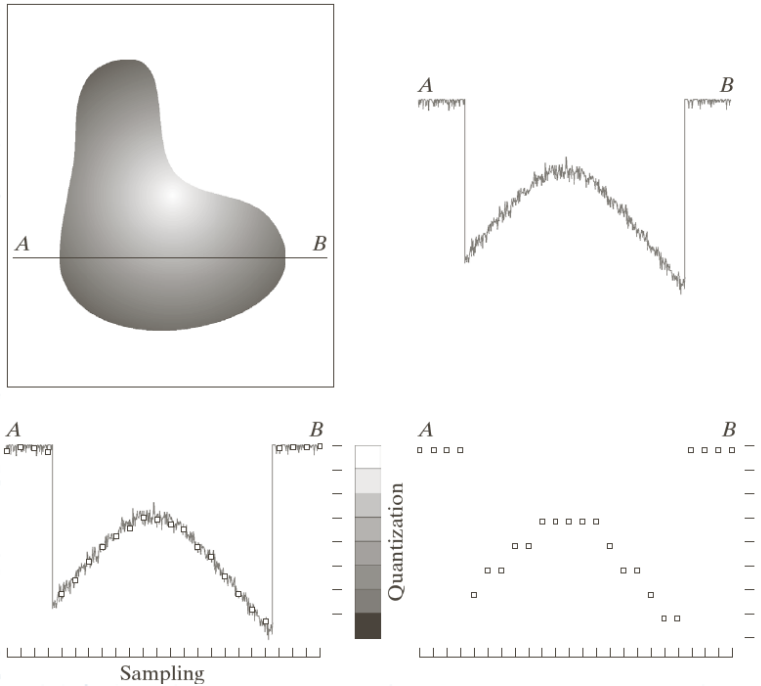
$\{t_k, k = 1, 2, 3, \ldots. L+1\}$

- Where t_1 is the minimum value

t_{L+1} is the maximum value

$U' = r_k$ if $t_k < U < t_{k+1}$

Image Sampling and Quantization



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.

Digital Image Representation

- Depending on the number of gray levels (l), values of ***a*** will be different.
  - {0,1}, 1 bit: binary,
  - {1..256}, 8 bit: gray
  - {1..256}x{1..256}x{1..256}, 24 bits: color
- The number of bits, b, necessary to store the image is then

  b=n x m x l ; when n=m, $b = n^2 \times l$
  - For example, a 128x128 image with 64 gray levels would require 98,304 bits of storage

Gray level effects

256

128

64

32

Digital Image Definition

A digital image $a[m,n]$ described in a 2D discrete space is derived from an analog image $a(x,y)$ in a 2D continuous space through a *sampling* and *quantization* process that is frequently referred to as digitization.