计算机辅助手术讲座（1）
Image Guided Surgery (1)

INTRODUCTION
简介

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Who am I

- Name：顾 力栩 （Lixu Gu, Professor@SJTU）
- Research Interests：
  - Medical Image Processing， Pattern Recognition;
  - Computer Version， CG;
  - Minimal Invasive Surgery， Image-guided Surgery and Therapy， Surgical Navigation, Robotic Surgery.
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Course Preview-1

- Recommend Text Books：
  - Image-Guided Intervention
    - Terry Peters, Kevin Cleary
    - Springer Publish, inc.
- References：
  - “Morphological Image Analysis”, Pierre Soille，Springer Publishing
  - “Computer and Robot Vision”, R.M.Haralick & L.G.Shapiro， Addison-Wesly Publishing,1992

Course Preview-2

- Teaching Schedule：
  - Total 9 weeks, 18X2 lessons. Where, 12 courses，Project 5 times，and 1 final review。
- Grading:
  1. 项目实习 (Projects) 30%
  2. 期末考试（Final Exam) 70%

Teaching Schedule

1. Part 1: Basic Concepts (6)
   1) Introduction; Digital Image; Input/Output;
   2) Threshold and Binary Image
   3) Point Operation, Neighboring Operation
   4) Convolution, Correlation
   5) Image Filters
   6) Project 1
2. Part 2: Mathematical Morphology (6)
   1) Binary Morphology (1) (2)
   2) Grayscale Morphology (1) (2)
   3) Exercise & Project 2

Teaching Schedule

3. Part 3: Image Guided Surgery (4)
   1) History and tracking device
   2) Display and Visualization
   3) Segmentation and registration
   4) Neurosurgical applications
4. Deformable Model and Level set (option)
5. Final Exercise and Exam

Image and Digital Image

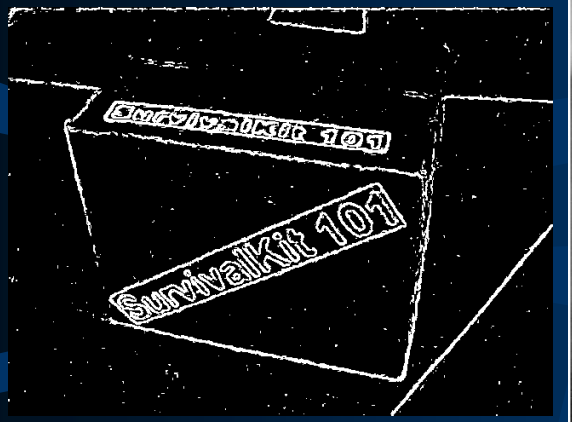
What's an image and A digital image

- A digital image is defined a 2-D function, f(x,y), where x and y denote spatial coordinates and f is called intensity or gray level at the point of (x,y)
- Digitization: manipulation with computer
  - Must choose pixel size (maximum possible resolution)
  - Must choose number of gray levels, dynamic range
  - Loss of information
- Data:
  - Dimensionality (2 or 3, sometimes more)
  - Large (usually 10MB to over 1GB)
  - Every voxel maps to a point in physical space

Image Categories

- Binary image, gray level image, color image, false color image…
- Sensor: optical, infrared, ultraviolet, x-ray, Radar, MRI (RF), ultrasound, microwave …
- Dimension: 2D, 3D, 4D,…
- Sensing platform: satellite (geography), microscope, X-ray film, MRI machine…

TYPES OF IMAGE



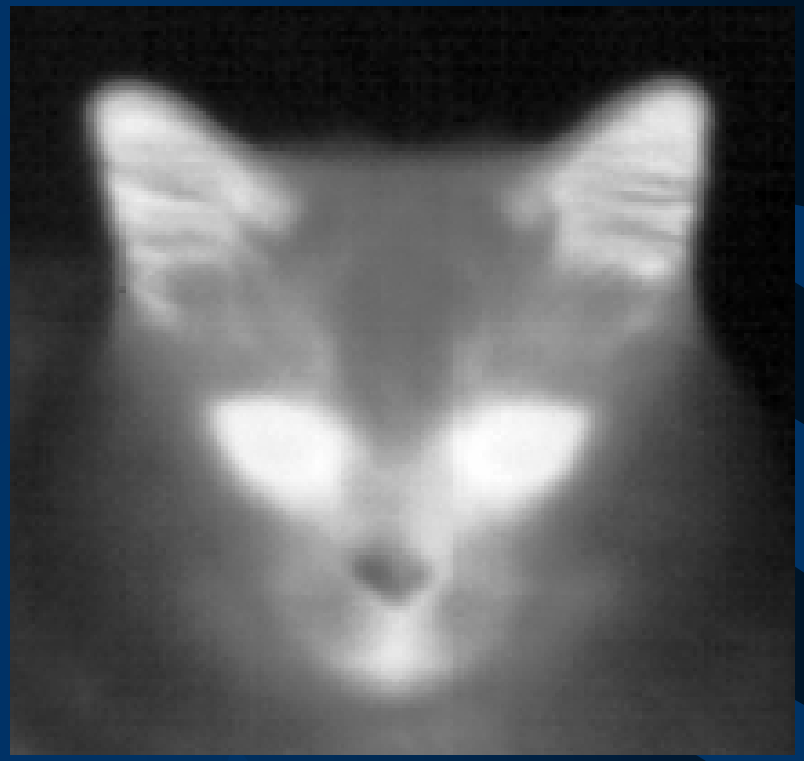
Binary image

Gray level image

Color image

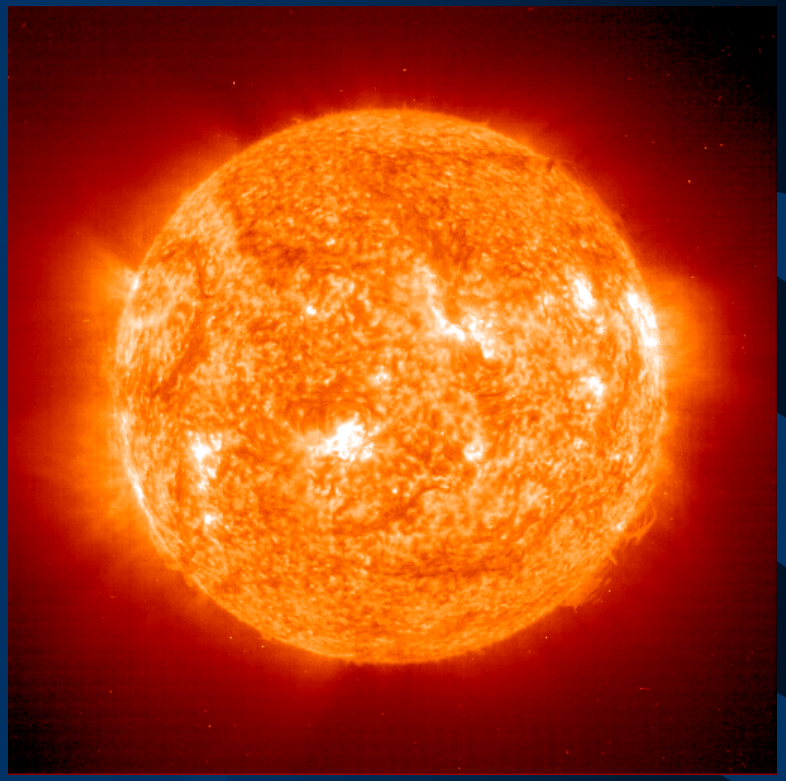
INFRARED IMAGE

False color image



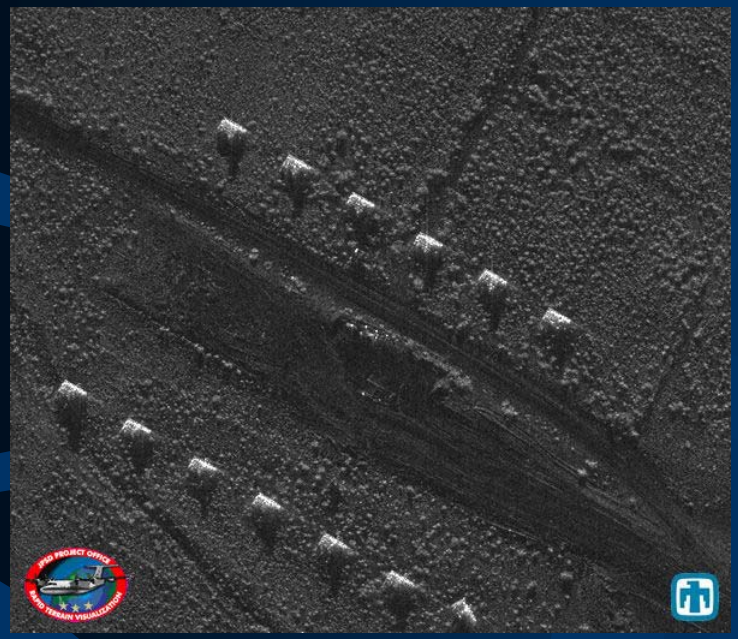
Gray level image

ULTRAVIOLET IMAGE



Sun UV-image

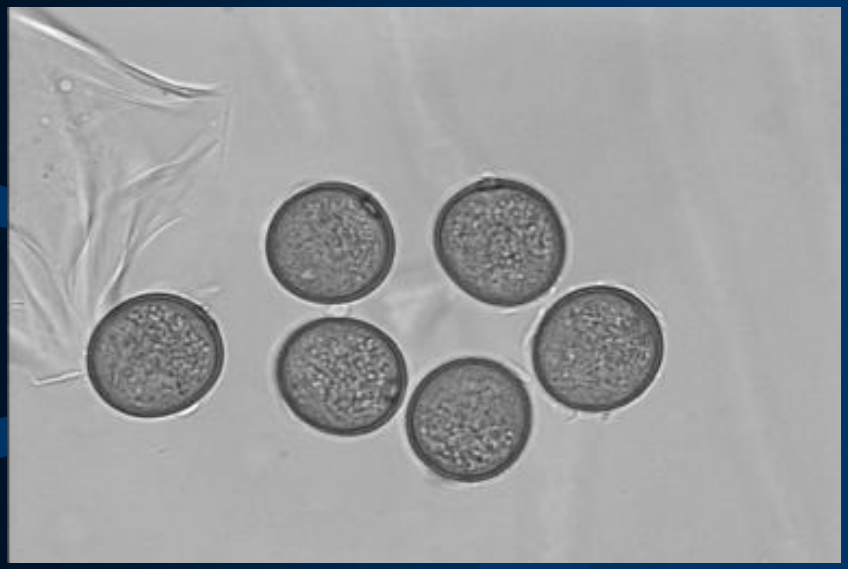
SYNTHETIC APERTURE RADAR (SAR) IMAGE



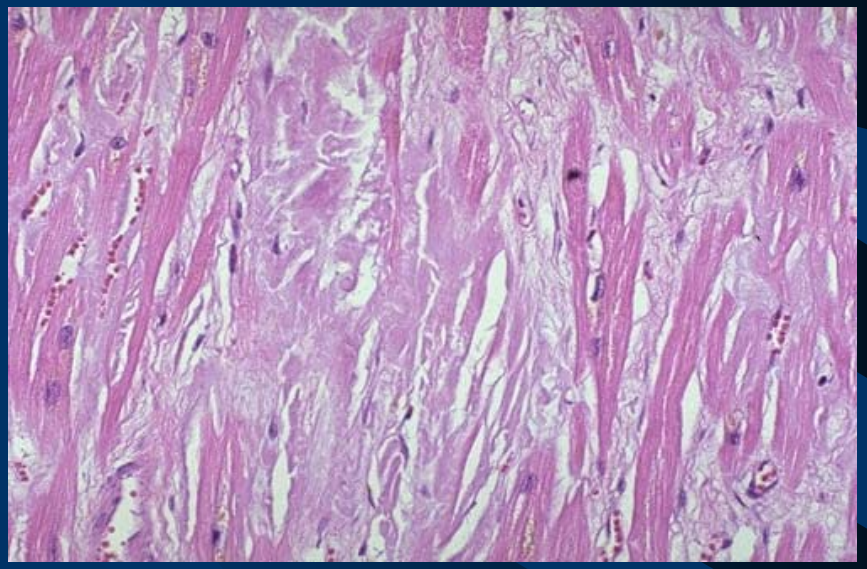
SAR aerial image

SAR satellite image

MICROSCOPIC IMAGE

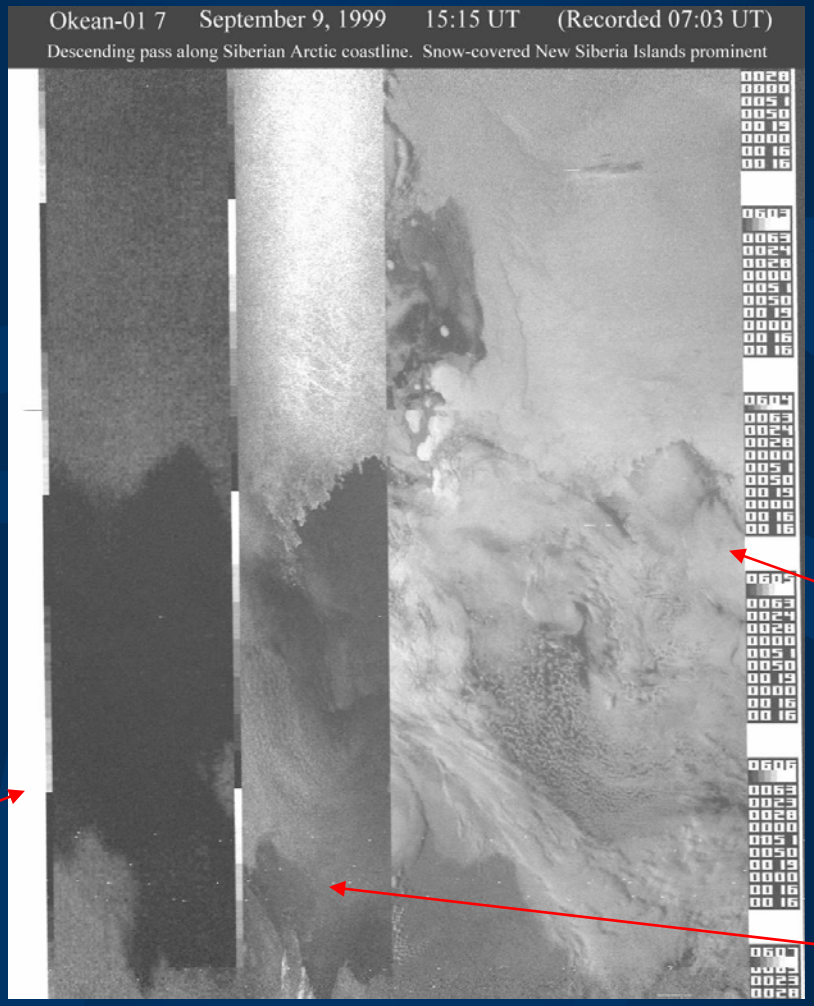


Pollen image



Myocardium image

MICROWAVE IMAGE

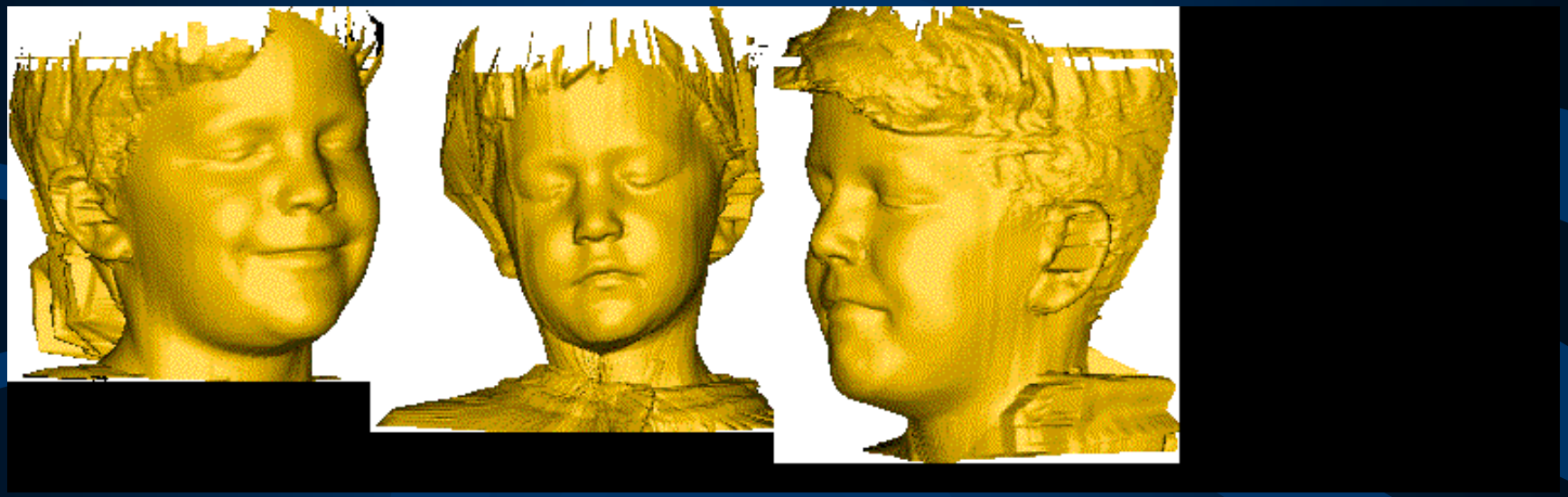


Optical

Microwave

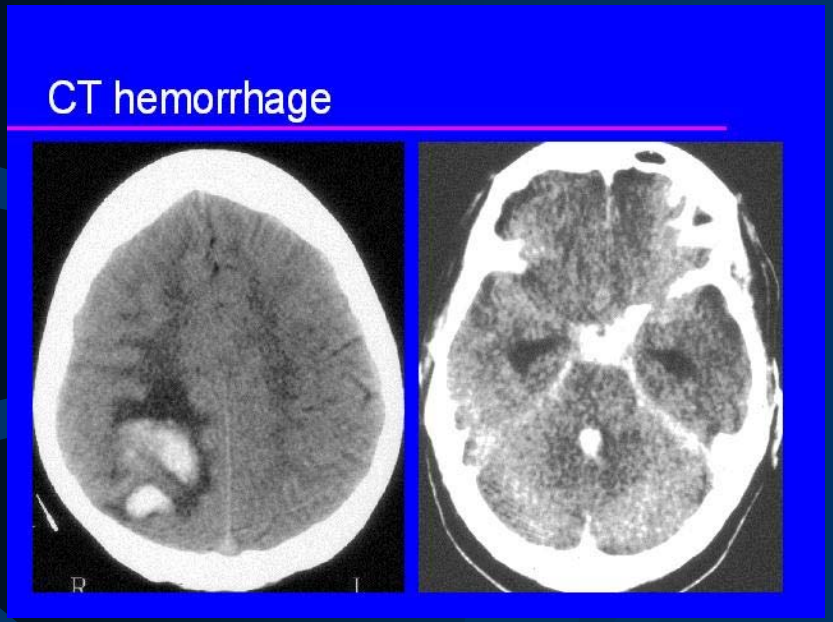
RADAR

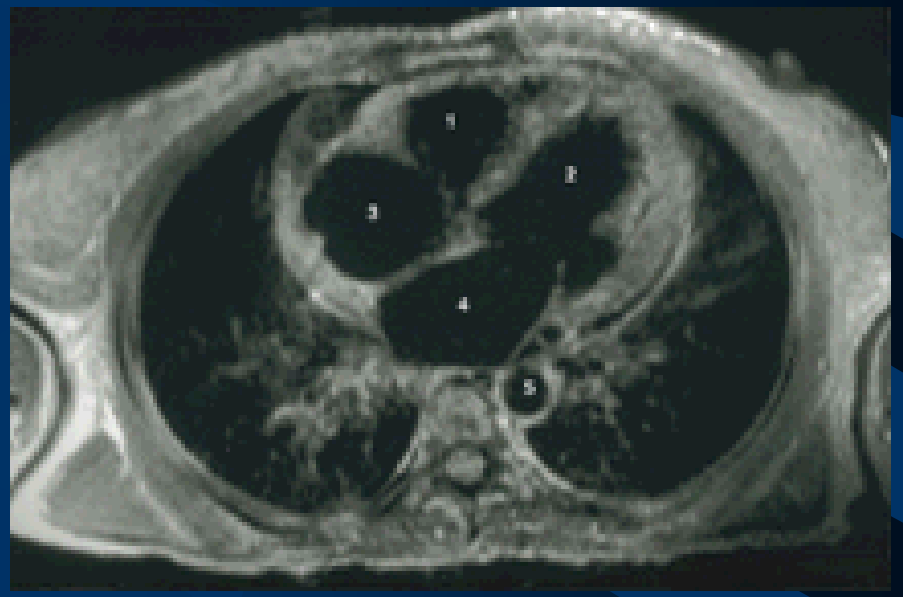
LASER RANGE FINDER IMAGE



Perspective view of 3D laser image

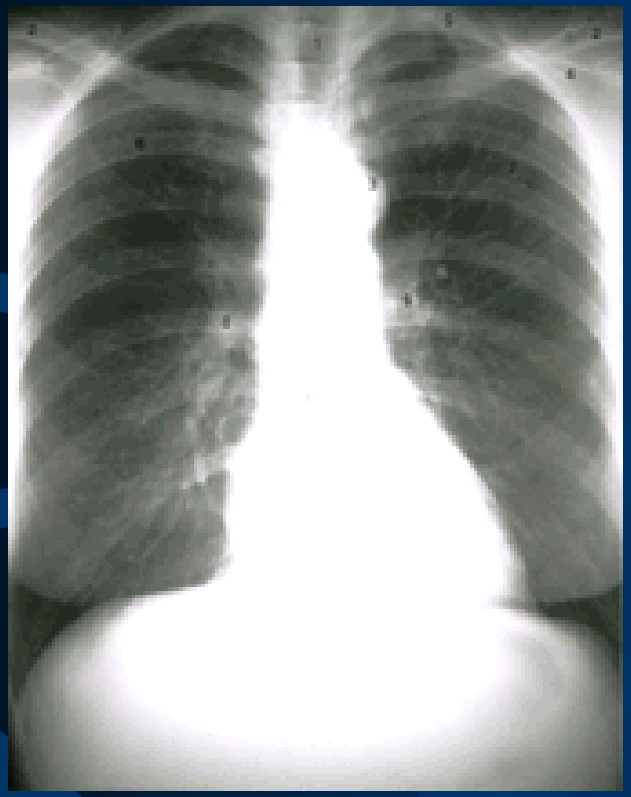
MEDICAL IMAGING



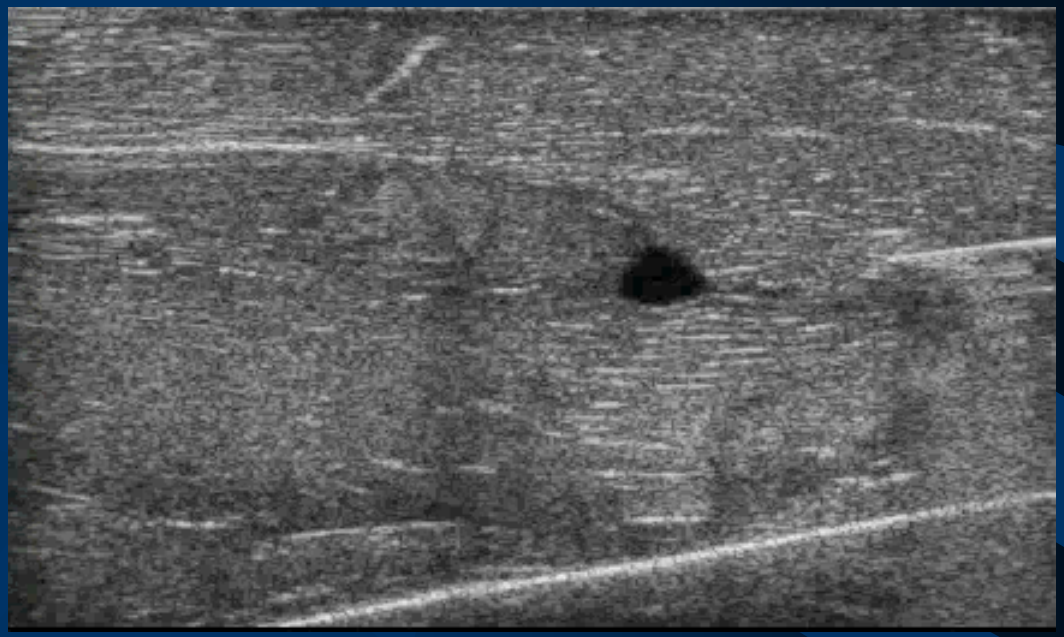


MRI IMAGE

MEDICAL IMAGING

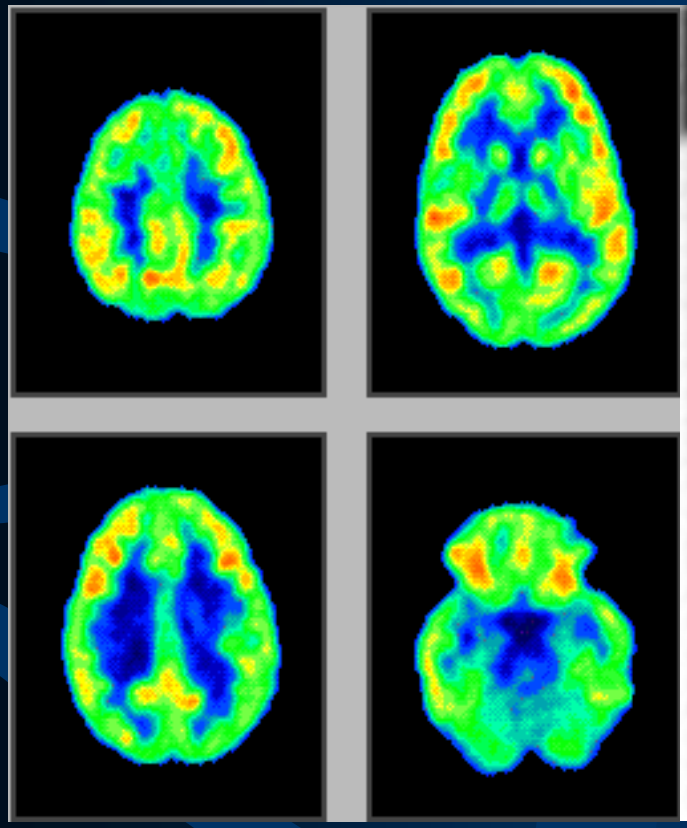


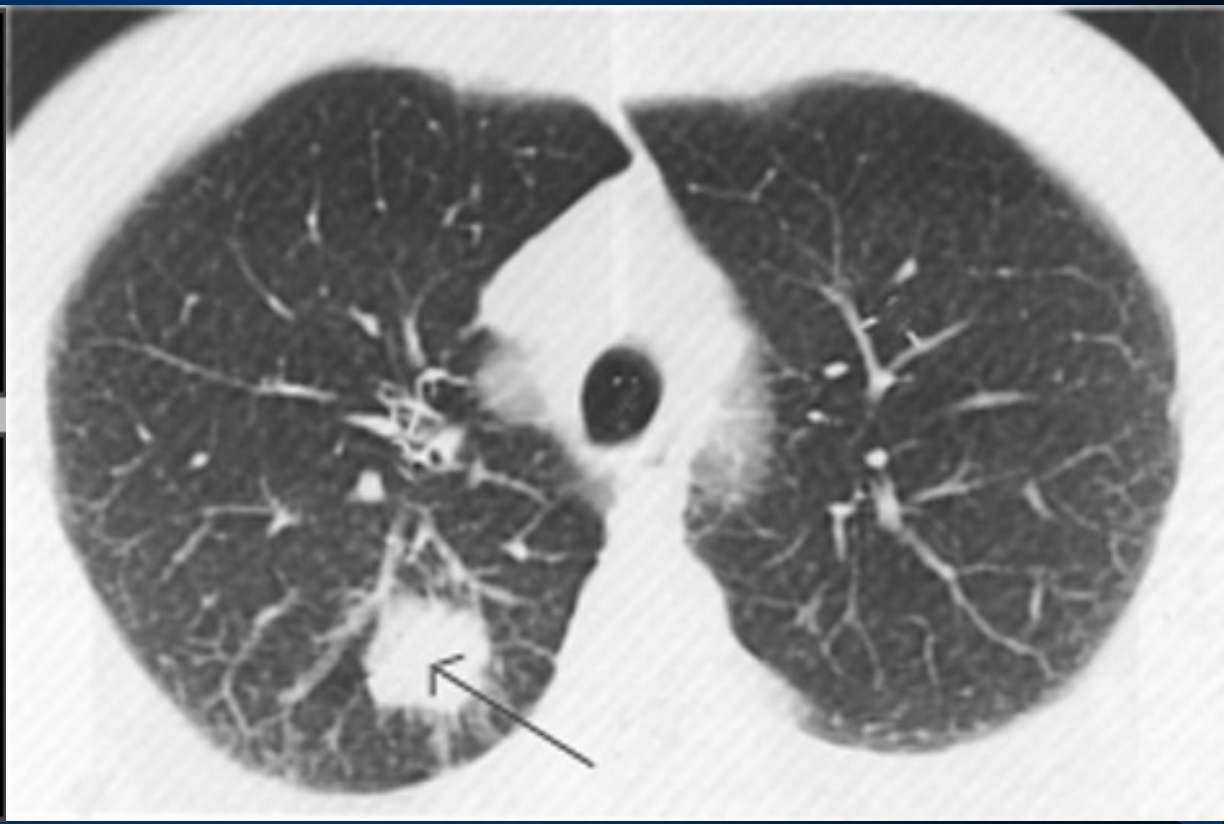
X-RAY IMAGE



ULTRASOUND IMAGE

Positron Emission Tomography (PET)





BRAIN

LUNG

3D ULTRASOUND IMAGE

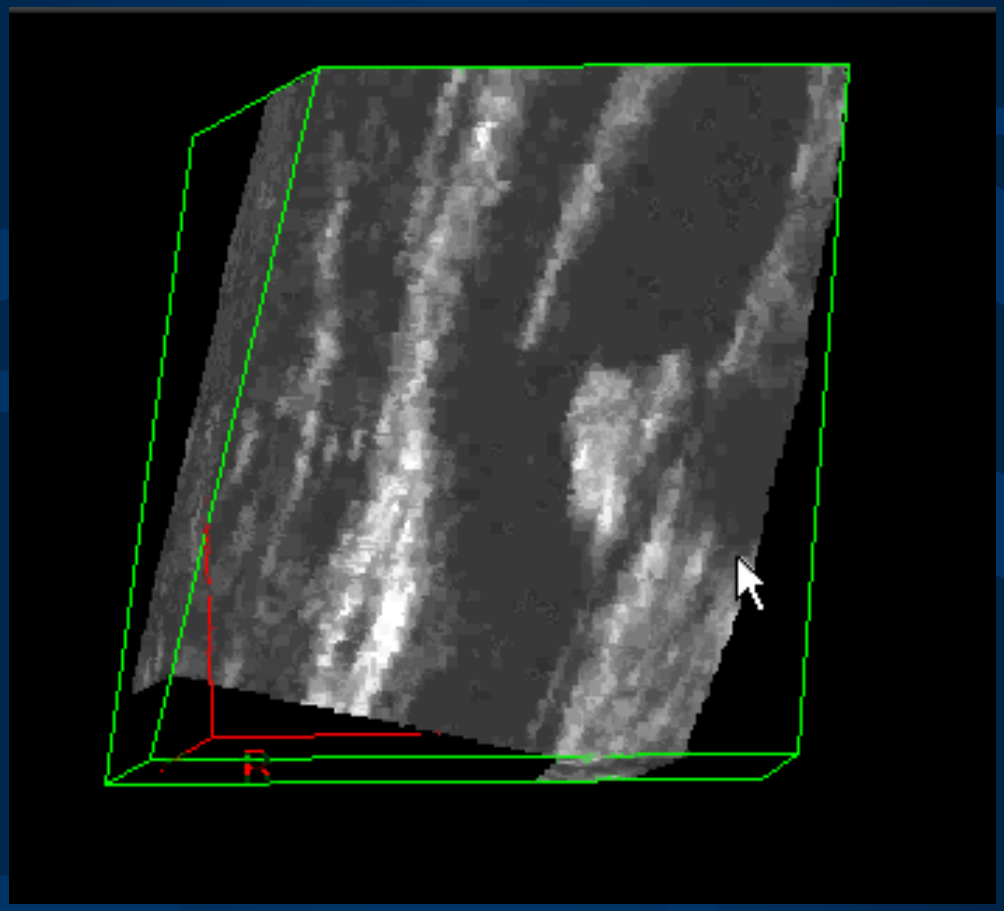


IMAGE SEQUENCE (VIDEO)

Image Description

An image is represented by an array.

2D image: f(i,j)

3D image: f(i,j,k)

4D image: f(i,j,k,t)

Here i,j,k,t and f(i,j,k,t) are integers

Digital Image

- Main equipments：
  - ❖Input： an image digitizer
  - ❖Output： an image display device
- Digital Image structure：
  - ❖Pixel (picture elements）-- 画素
  - ❖Gray level – 灰度值
  - ❖Coordinates – 坐标

Digital Image Processing

- Digit： calculation by numerical methods or by discrete units (pixel).
- Digital Image： numerical representation of an object.
- Digital Image Processing: subject a numerical representation of an object to a series of operations in order to obtain a desired result, which including processing and analysis.
- Task: math modeling + solving method + software programming

Digital Image Processing

- Computer Graphics：
  - ❖processing and display of images of things existing conceptually or as mathematical descriptions rather than as solid objects.
  - ❖Model, illumination, and geometry of an imaginary camera.
  - ❖“computer art”
- Computer Vision： developing systems that can interpret the content of nature scenes.

Digital Image Processing

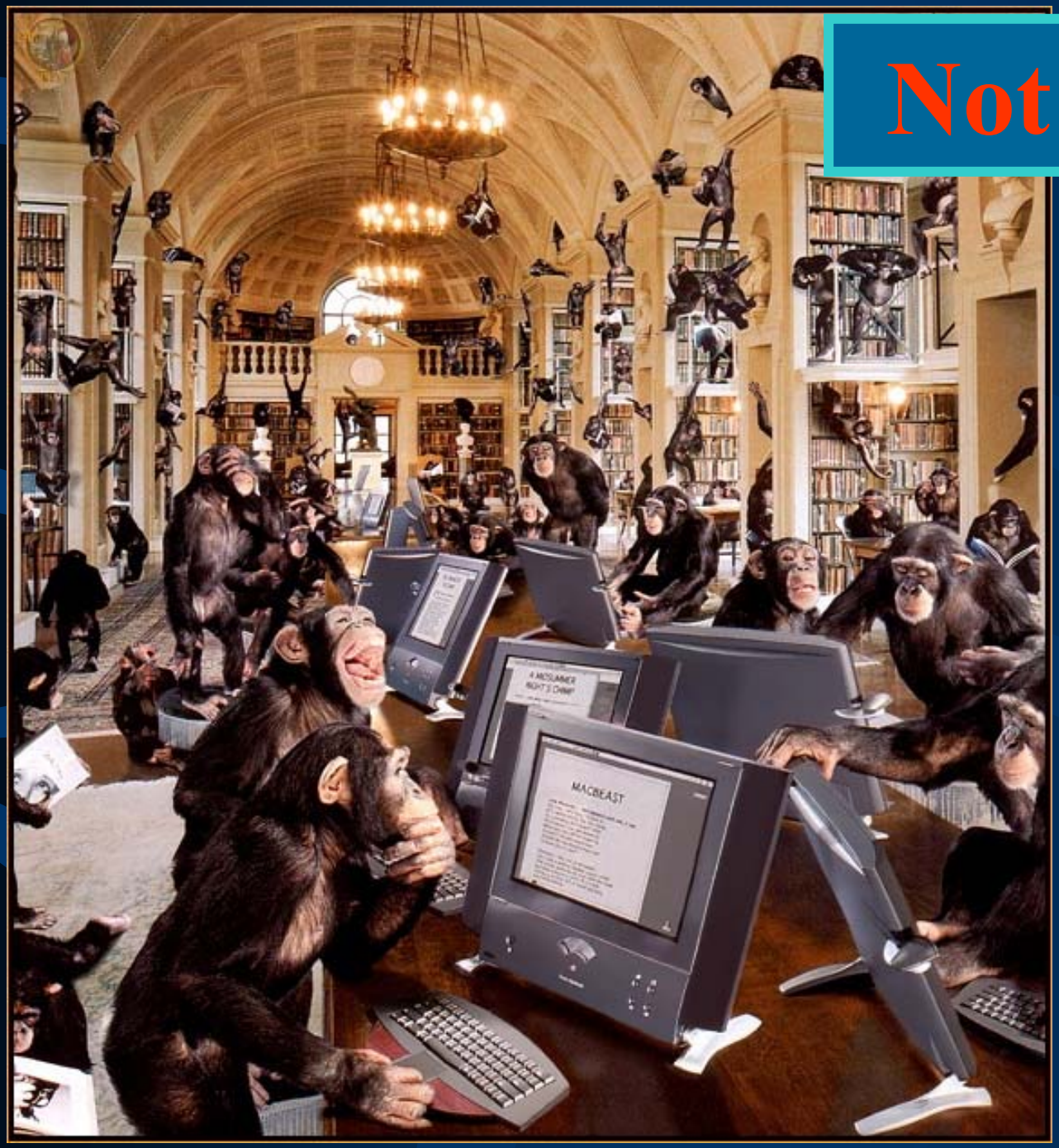
- Sampling（取样）: measuring the graylevel of an image at each pixel location.
- Quantitization（量子化）: presentation of a measured value by an integer.
  - ❖ Reduce continuous values to discrete units
  - ❖ Represent by integers

Digital Image Processing

- Contrast（对比度）: amplitude of gray-level differences within an image.
- Resolution（解像度）: the number of gray level per unit of measure of image amplitude.
- Sampling density: pixel spacing
- Magnification（放大率）: the size relationship between the objects in an image and that in the scene it represents.

Format of A Digital Image

- 2D image:
  - raw image, .bmp, .tif, .jpg, .gif, …
- *3D image:*
  - *raw+extra info, .vox, .mnc, .dicom,…*



Not Enough?

Go Library!

Discussion