Medical Imaging
&
Image Processing

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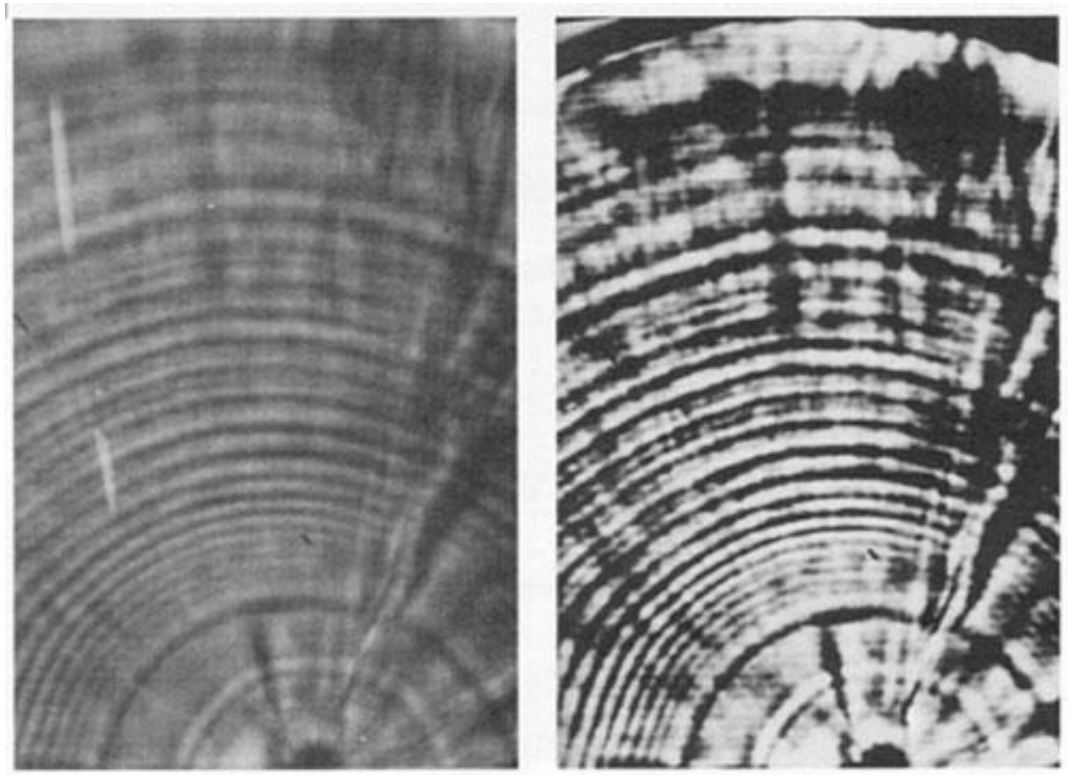
Images – Capturing and Processing

Image Concepts

- An image is a function of intensity values over a 2D plane *I(r,s)*
- Sample function at discrete intervals to represent an image in digital form
  - matrix of intensity values for each color plane
  - intensity typically represented with 8 bits
- Sample points are called pixels

Image Representations

- Black and white image
  - single color plane with 2 bits
- Grey scale image
  - single color plane with 8 bits
- Color image
  - three color planes each with 8 bits
  - RGB, CMY, YIQ, etc.
- Indexed color image
  - single plane that indexes a color table
- Compressed images
  - TIFF, JPEG, BMP, etc.



4 gray levels 2 gray levels

Digital Image Processing, Gonzalez & Woods , Pearson, 2007.

Digital Image Representation

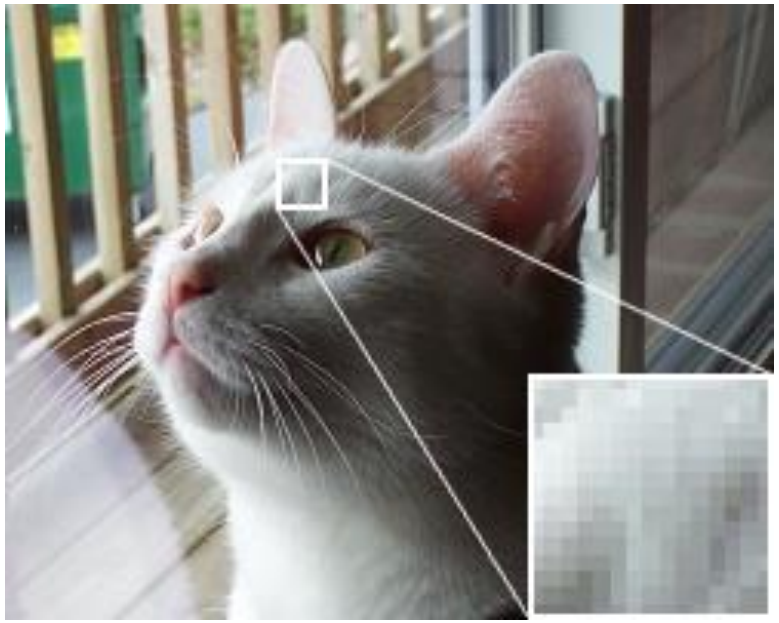
(3 Bit Quantization)

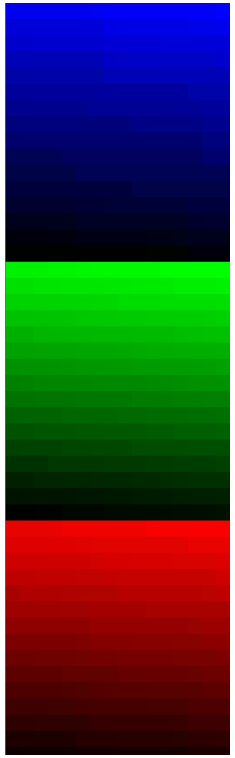
111	111	011	011	011	011	111	111
111	011	111	111	111	111	011	111
000	111	001	111	111	001	111	000
010	111	111	111	111	111	111	010
000	111	100	111	111	100	111	000
000	111	111	100	100	111	111	000
111	000	111	111	111	111	000	111
111	111	000	000	000	000	111	111

Digital Image Processing, Gonzalez & Woods , Pearson, 2007.

Color Quantization

Example of 24 bit RGB Image

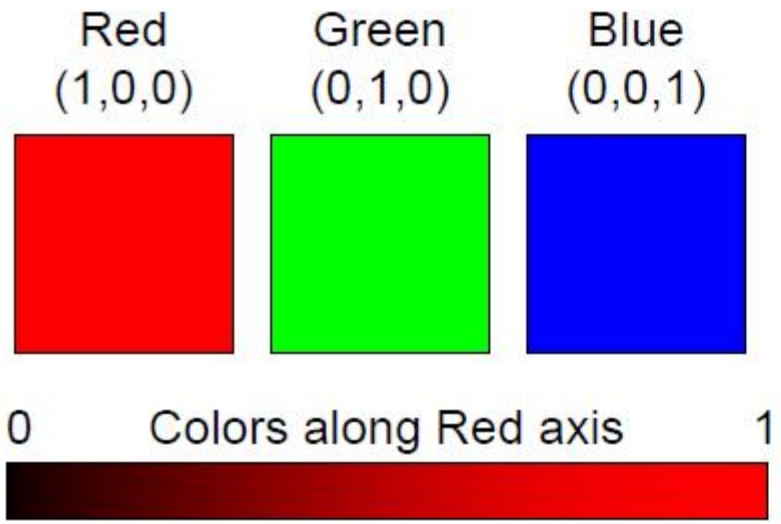


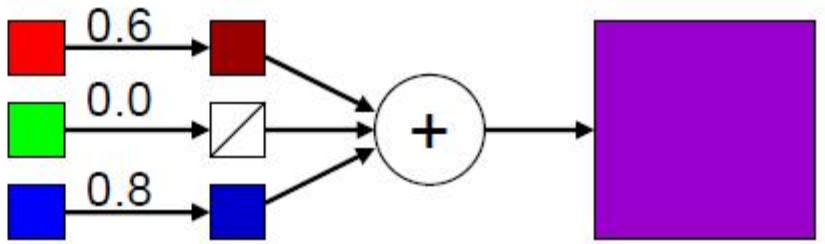


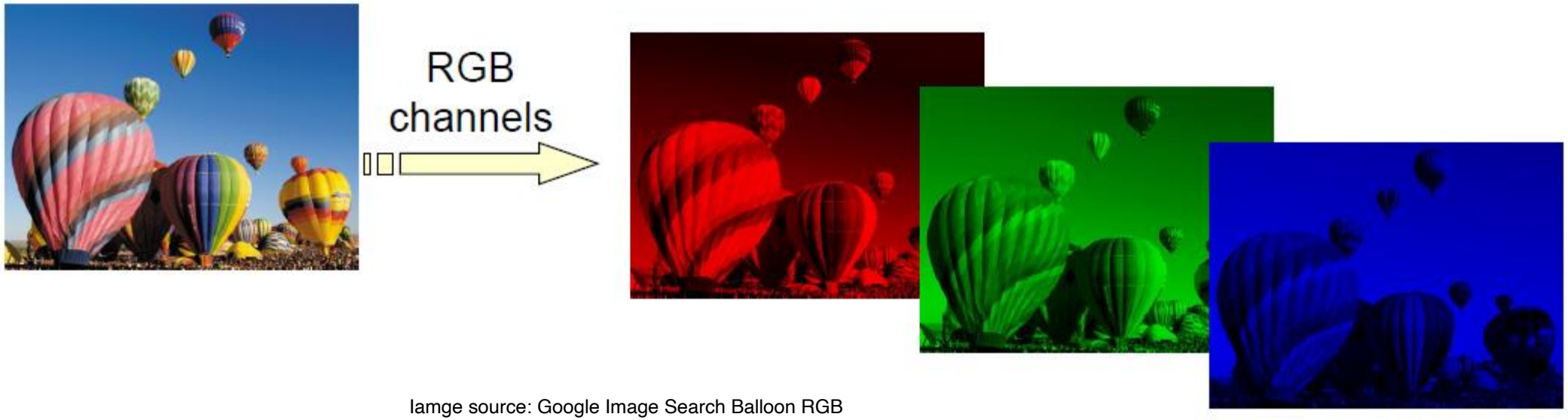
24-bit Color Monitor

Iamge source: Google Image Search Cat RGB

Color







Iamge source: Google Image Search Balloon RGB

Image Representation Example

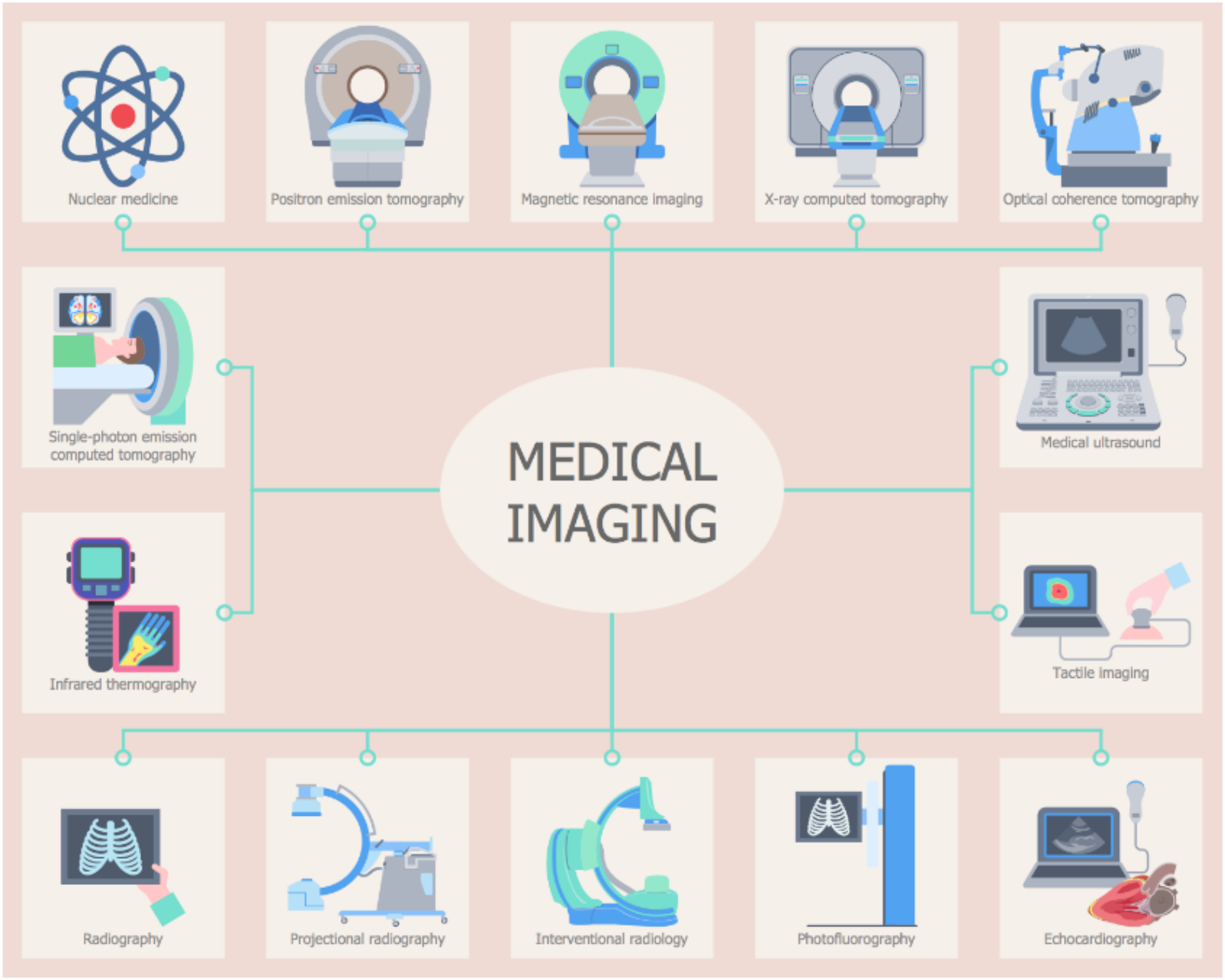
24 bit RGB Representation (uncompressed)

128	135	166	138	190	132
129	255	105	189	167	190
229	213	134	111	138	187

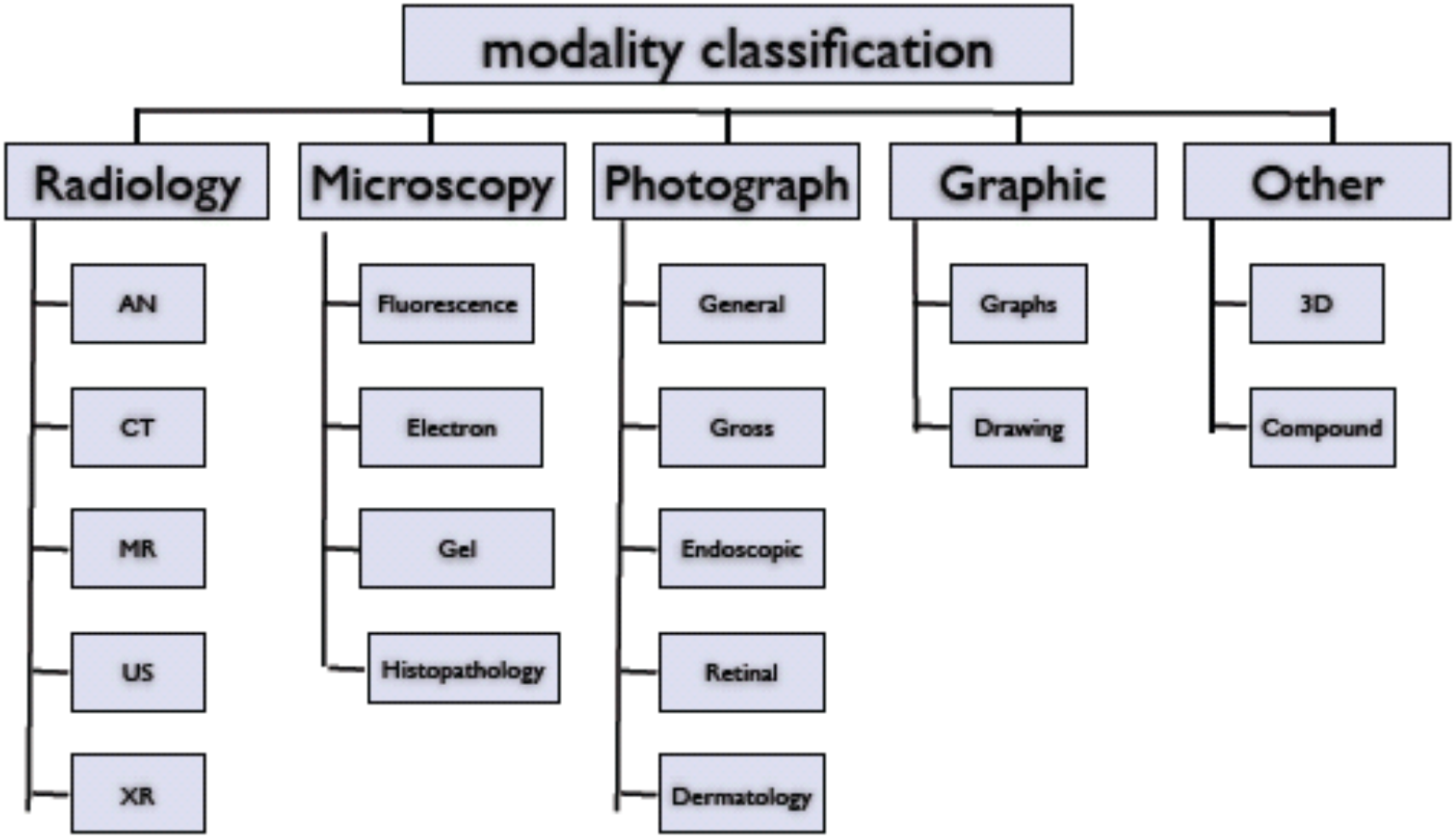
128	138	135	190	166	132
129	189	255	167	105	190
229	111	213	138	134	187

Color Planes

Medical Image Processing, Sinha & Patel, PHI Learning, 2014

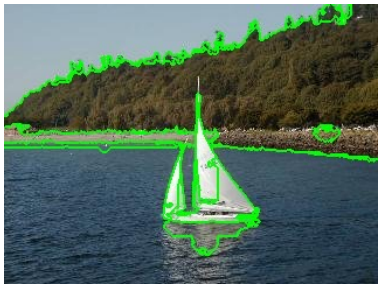


https://www.conceptdraw.com/How-To-Guide/medical-imaging

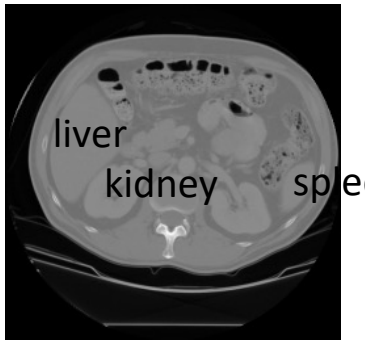


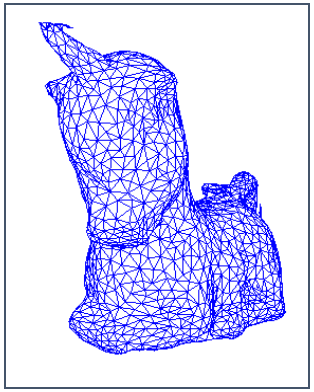
https://www.imageclef.org/2011/medical

Goals of Image and Video Analysis



- Segment an image into useful regions
- Perform measurements on certain areas
- Determine what object(s) are in the scene
- Calculate the precise location(s) of objects
- Visually inspect a manufactured object
- Construct a 3D model of the imaged object
- Find “interesting” events in a video





Digital Image Processing, Gonzalez & Woods , Pearson, 2007.

3D Sensors

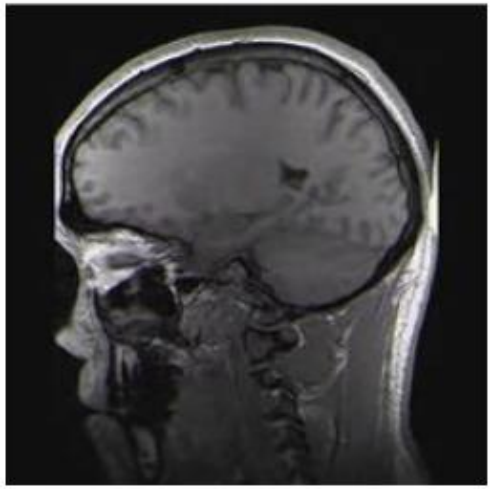
- Laser range finders
- CT, MRI, and ultrasound machines
- Sonar sensors
- Tactile sensors (pressure arrays)
- Structured light sensors
- Stereo

MRA (angiograph) showing blood flow.

Areas where imaging is used

- Medical imaging
- Remote Earth resource observations
- Astronomy
- High-energy plasmas and electron microscopy

Imaging Examples



1. Brain MRI

2. Cardiac CT

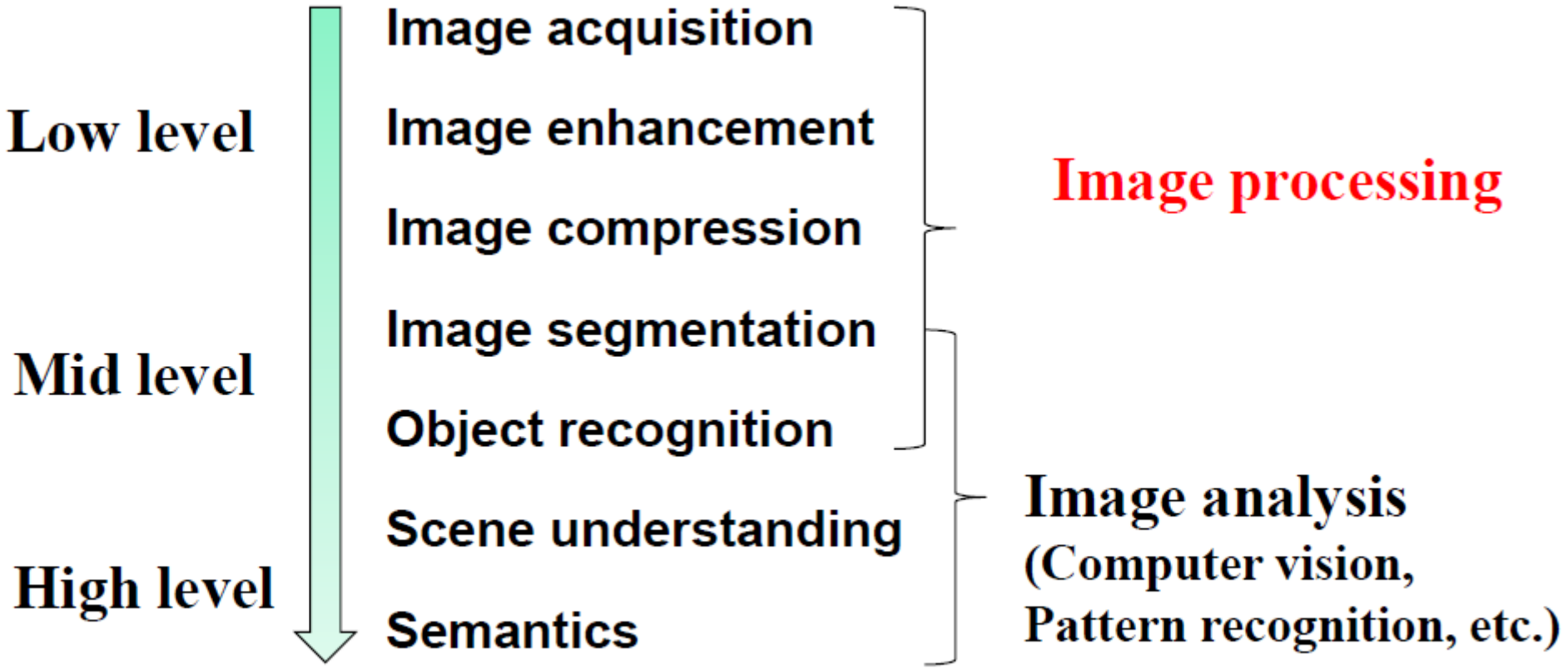
3. Fetus Ultrasound

4. Satellite image

5. IR image

1 and 3. http://en.wikipedia.org
2. http://radiology.rsna.org
4. http://emap-int.com
5. http://www.imaging1.com

From Processing to Analysis



Fundamental Steps in Digital Image Processing

- Methods whose input and output are images
- Methods whose outputs are attributes extracted from those images

Flow of Digital Image Processing

Image acquisition: It deals with capturing images or samples.

Image enhancement: It deals with the improvement of quality of images.

Image representation: It deals with different ways in which image can be represented mathematically, graphically and statistically.

Image transformation: It is used to transform the input image from one domain into another, e.g. an image in spatial domain can be converted into frequency domain by using Fourier transform.

Image restoration: It deals with the analysis and modeling of different types of noise mixed in images.

Color image processing: Various colour spaces and formats are covered in it.

Flow of Digital Image Processing

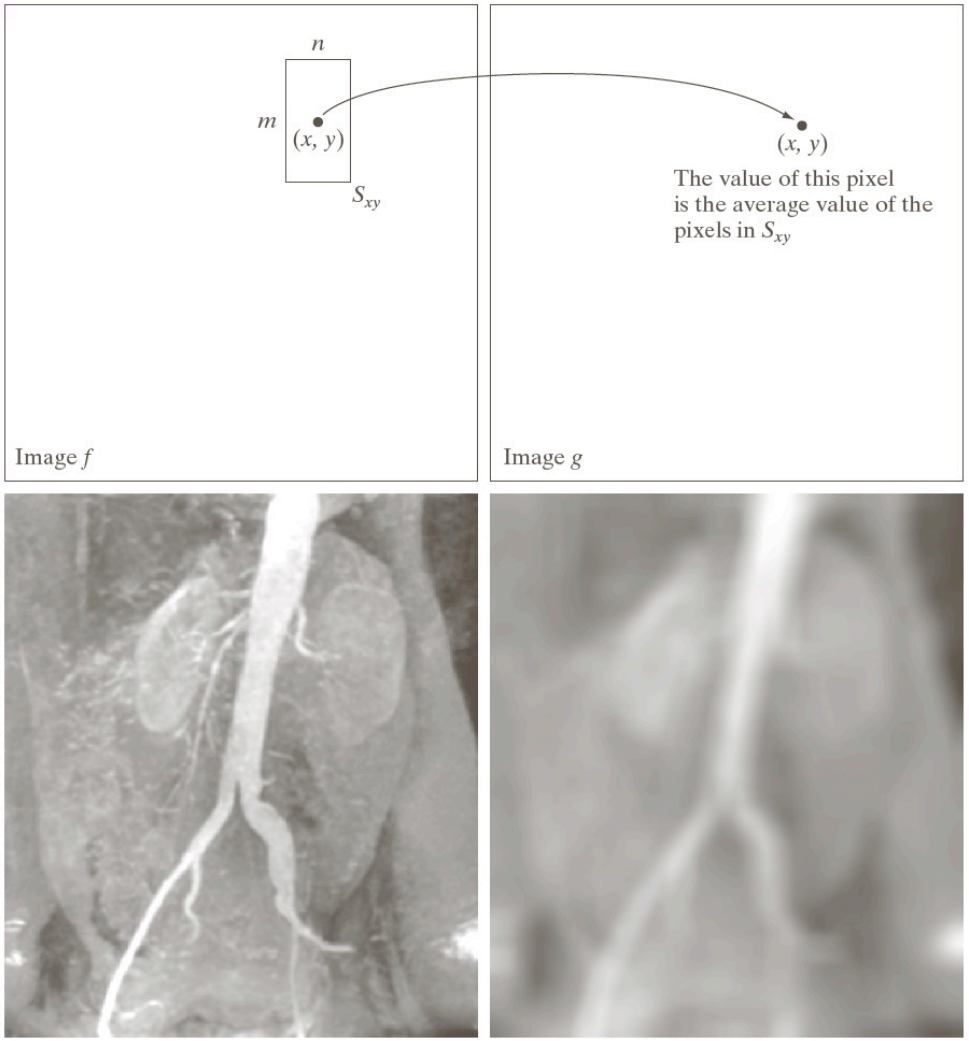
Image compression: It is used to reduce the size of image or reduce redundancy without any significant change in the inherent content of the image.

Morphological image processing: It is used to represent or convert into suitable forms so that edges can be easily recovered. These operations are generally used with image segmentation.

Image segmentation, representation and description: The selected region of interests can be extracted and various boundaries, edges and other similar information could be obtained.

Object recognition: It deals with the pattern recognition and matching.

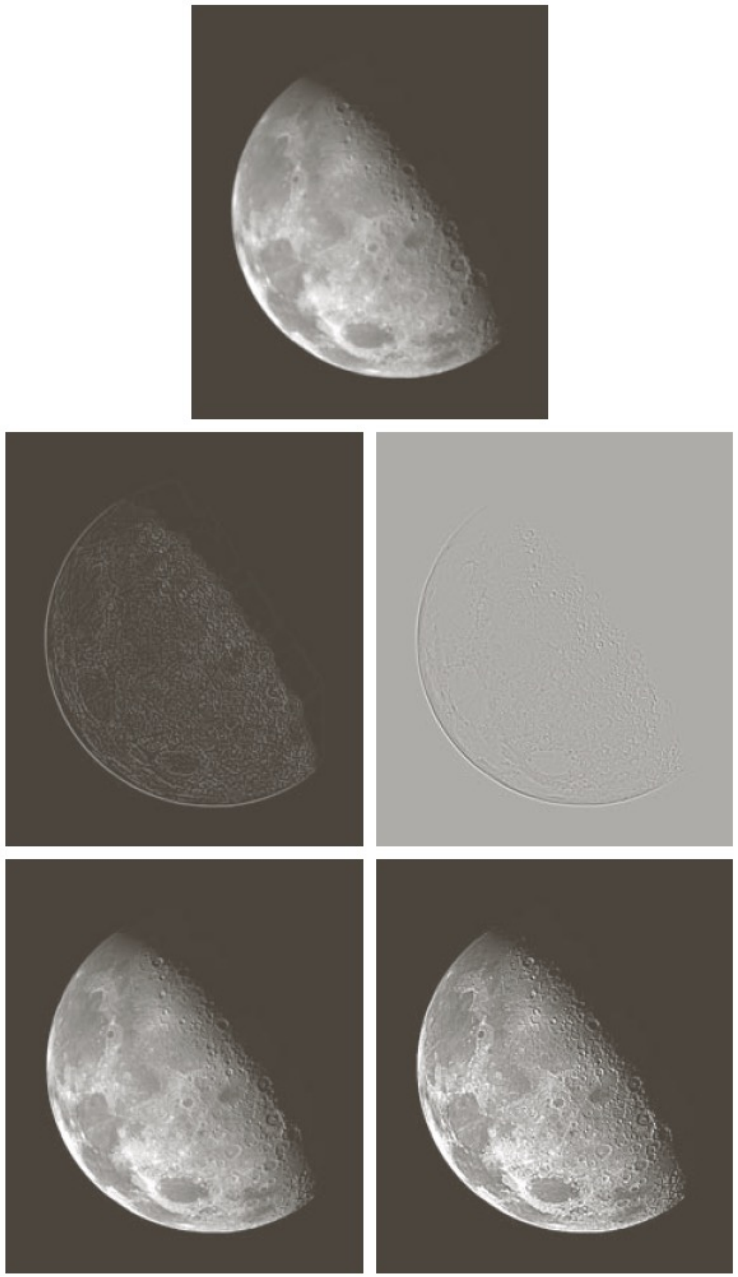
- Image operations



a b
c d

FIGURE 2.35
Local averaging using neighborhood processing. The procedure is illustrated in (a) and (b) for a rectangular neighborhood. (c) The aortic angiogram discussed in Section 1.3.2. (d) The result of using Eq. (2.6-21) with $m = n = 41$. The images are of size 790 × 686 pixels.

- Spatial filtering



a
b c
d e

FIGURE 3.38
(a) Blurred image of the North Pole of the moon. (b) Laplacian without scaling. (c) Laplacian with scaling. (d) Image sharpened using the mask in Fig. 3.37(a). (e) Result of using the mask in Fig. 3.37(b). (Original image courtesy of NASA.)

Image Restoration

Digital Image Processing, Gonzalez & Woods , Pearson, 2007.

https://www.digimizer.com/manual/m-image-filtergeomean.php

Textbooks

- Machine Vision, Wesley E. Snyder & Hairong Qi,
- Medical Image Processing: Concepts And Applications, Sinha G. R, Patel, B. C., Prentice Hall, 2014.
- Insight into Images: Principles and Practice for Segmentation, Registration and Image Analysis, Terry S. Yoo
- Biosignal and Medical Image Processing, John L. Semmlow, , CRC Taylor and Francis, 2008