Purpose of medical imaging
Acquiring anatomy and physiology information from a patient

X-rays

Medical Image Processing

- Medical imaging
  - X-ray, CT
  - Ultra-sound
  - MRI
  - PET, SPECT

- Generic problems
  - Enhancement
  - Registration
  - Segmentation
  - Interpretation

- Visualization
  - MPR, MIP
  - Surface, and volume rendering
X-ray Technique
High energy EM waves, $\lambda = 0.5 - 10^{-2} \text{Å}$.
X-rays
Mammography

Computed Tomography (CT)
3D imaging using X-rays

CT Technique
High energy EM waves (X-rays)

CT
Skeleton
Positron Emission Tomography (PET)
3D imaging by injecting radioactive isotope in bloodstream

PET
Positrons collide with electrons emitting gamma rays

PET Examples

Single Photon Emission Computed Tomography (SPECT)
Scintigraphy
SPECT Technique
Radioactive isotope injected, which decay while emitting gamma rays

Magnetic Resonance Imaging (MRI)
Radio frequency signals from atoms in rotating magnetic field

MR
Muscular-skeletal (joints)

MR
Neurological (Multiple sclerosis seen below)
Other medical imaging modalities

- Microscopy

Generic problems in medical imaging processing

- Enhancement
- Registration
- Segmentation
- Interpretation

Enhancement
Noise (E.g., in MRI)

- Requires good knowledge of imaging physics.
- It also requires a good approximation algorithm.

Enhancement
Background

- Requires good knowledge of imaging physics.
- It also requires a good approximation algorithm.
Registration
Matching two volumes by applying geometric correction to one of them

The need for registration.
- Study over time
- Fusion of different imaging modalities
- Matching to atlas
- Organ movement

Segmentation
The need for more sophisticated algorithms

- Deformable models
- Watershed
- Level set method
- Fuzzy connectedness

More of this in the course Image Analysis MN2

Interpretation
Labeling from segmentation
- Top-down image analysis
- Expert systems

Artificial intelligence

Visualization of medical images

- 2D
- 3D
  - Multi-planar reconstruction
  - Maximum intensity projection (MIP)
  - Surface rendering
  - Volume rendering
Shade surface display (SSD)

- Preliminary segmentation
- Voxel set → surface
- Surface elements rendered according to illumination model
- Optional to texture

Volume rendering
Reflection/transmission properties assigned to each voxel
Volume rendering

The Visible Human Project

Perspective

- Fusion of techniques
  - Dual imaging devices
  - Image processing
- Real time imaging/Virtual surgery
- Higher power, but tougher problem
- Complete automation unattainable
  - Good interaction more feasible