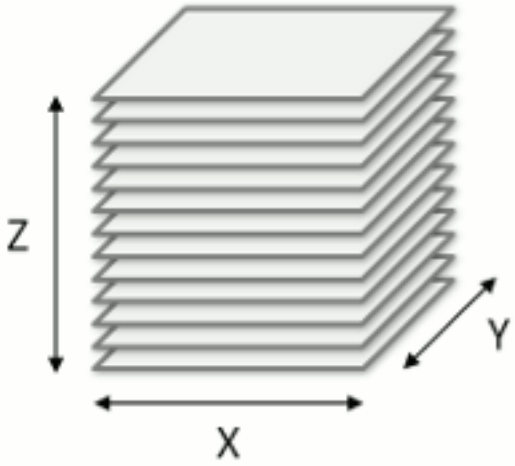
Module 11a:
Introduction to Volumetric Data

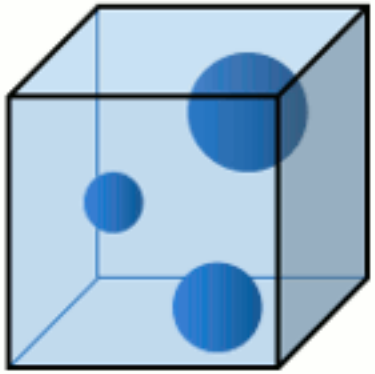
Objectives

- Discuss the fundamentals of volumetric data
- Describe multiple 3D acquisition systems in medicine / medical imaging
- Start reviewing different visualization techniques to illustrate 3D data

Volumetric Data

- Advances in 3D data acquisition systems have made volumetric data fairly common these days.
- There is a need to perform advanced analysis of the data.
- 3D data can be captured by various technologies such as MRI, CT, and PET.
- Volumetric data can also can be produced by physical simulations such as fluid dynamics or particle systems.





Case Study - Medical Imaging

- One of the primary applications of 3D data visualization
  - Medical images are widely available
  - Everyone understands the need for computational techniques to enhance medical images
  - Easy to establish collaborations (somewhat easier to get funding)

- University of Maryland Medical Center (2007)
  - 50 GB of 3D images a day
  - 15 TB in 2006

Outline

Fundamentals of Medical Imaging

- Acquisition
- CT
- MRI

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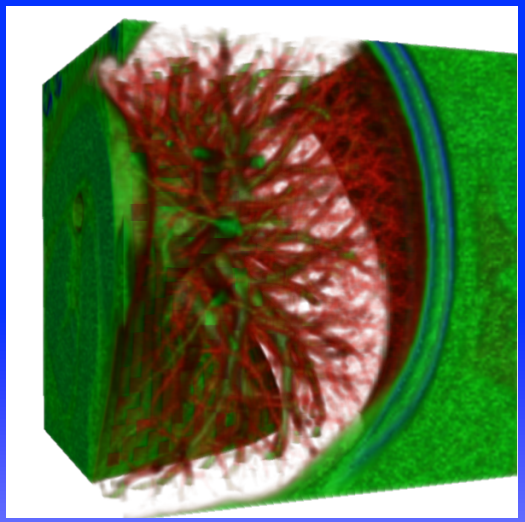

Fundamentals of Visualization

- Volume Rendering
- Transfer Functions
- Display Systems

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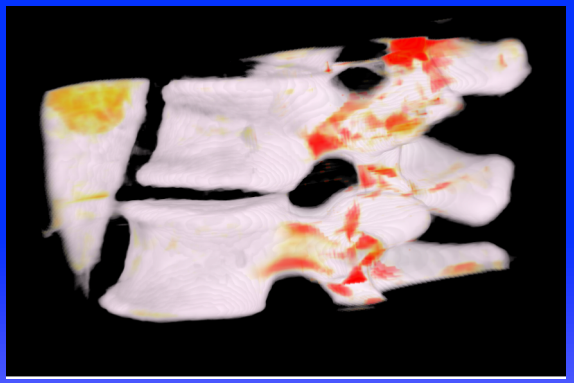
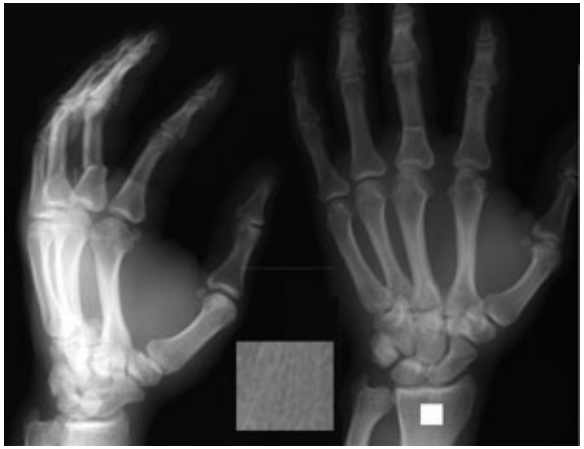


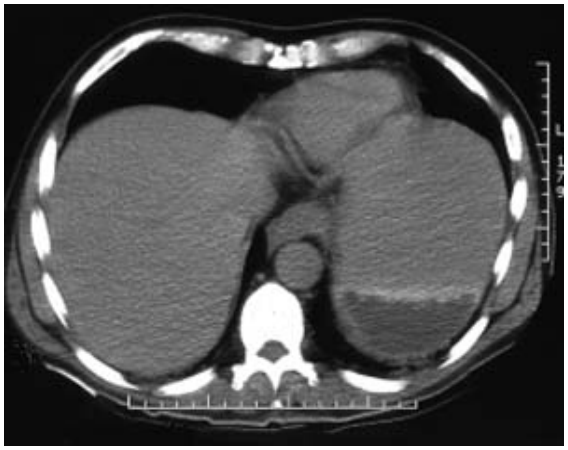
Analyzing and Processing Volumes

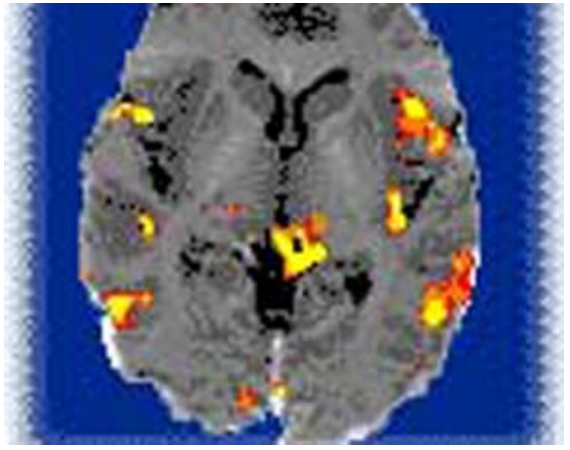
- Image Processing
- Statistical Volumes

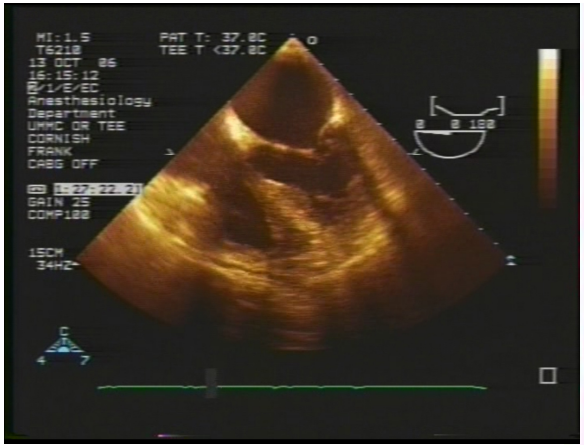
3

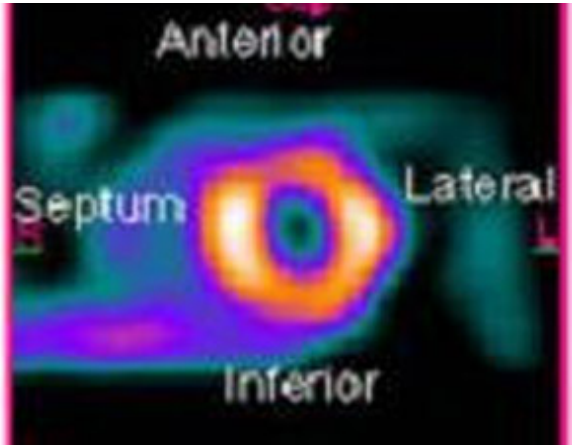
Examples of Medical Images

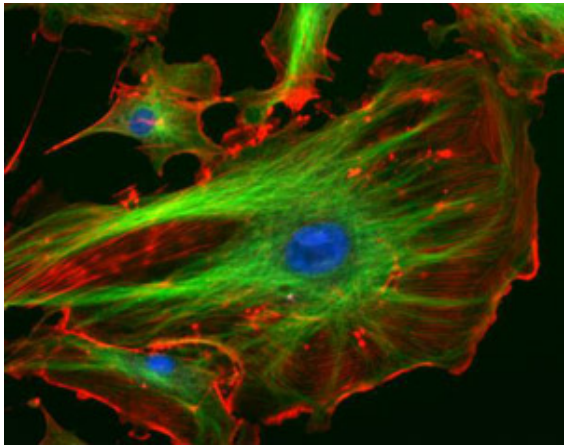












Medical Imaging - Acquisition

- Different devices are used for image acquisition
  - X-Ray, CT, MRI, PET, etc..
  - **Protocols:** With / without contrast
  - **Method:** Real-time or offline

- When are they used?
  - Purpose
    - X-Ray: Overview images
    - CT: Bone
    - MRI: tissue, muscles
  - Budget

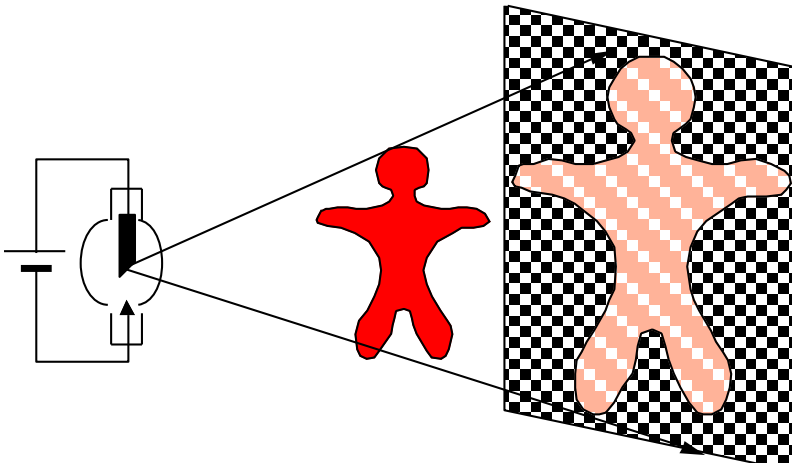
X-RAY

X-Ray Images

X-ray Imaging: How it works

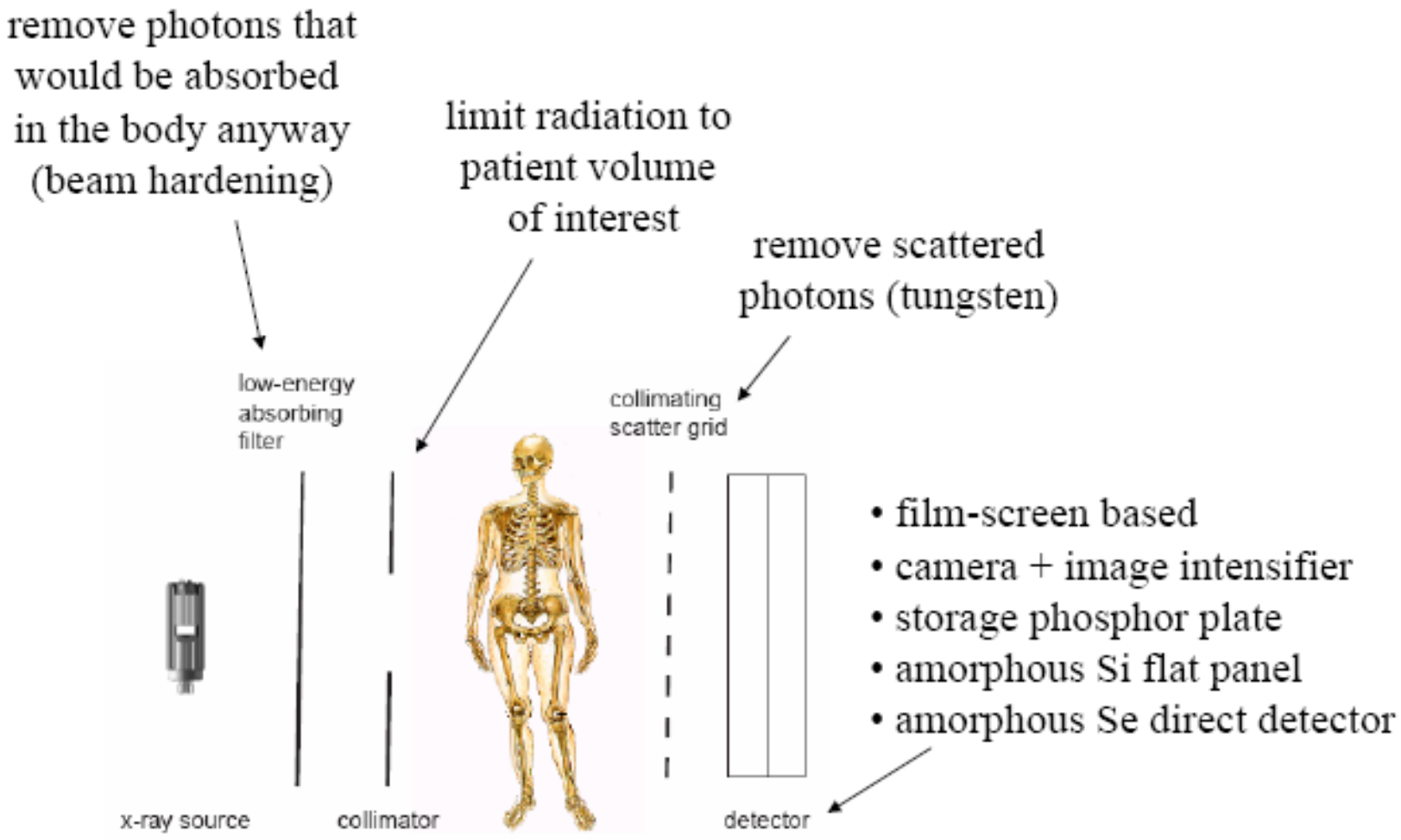
- Simplest imaging technique
- Wilhelm Röntgen in 1895
- Accidentally discovered
  - Accelerated electrons
  - *X-rays* (*X* for unknown)

X-ray Imaging: How it works



X-ray shadow cast by an object

X-ray Imaging: How it works



X-ray uses

- Radiographic images are made for all parts of the body
  - skeletal, chest (thorax, heart), mammography (breast), dental
- Mammography is somewhat behind because it requires resolutions that exceed that of storage phosphors
- X-ray images can be static or dynamic

Fluoroscopy –- X-ray

- X-ray image sequences are produced in real time
  - applications where motion is the subject of investigation
  - guidance for minimally invasive procedures
  - angiography (coronary imaging, vessels)
  - instrument tracking

Summary: X-ray Imaging

- Oldest non-invasive imaging of internal structures
- Rapid, short exposure time, inexpensive
- Unable to distinguish between soft tissues in head, abdomen
- Real time X-ray imaging is possible and used during interventional procedures.
- Ionizing radiation: risk of cancer.