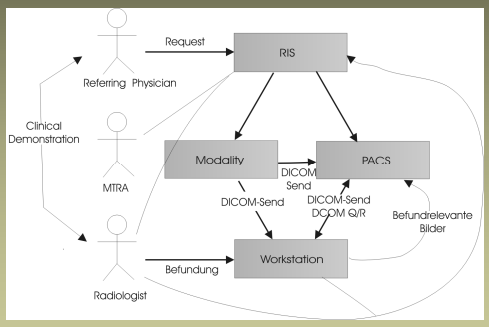
Medical Visualization in Radiology



Bernhard Preim, University of Magdeburg, Visualization research group

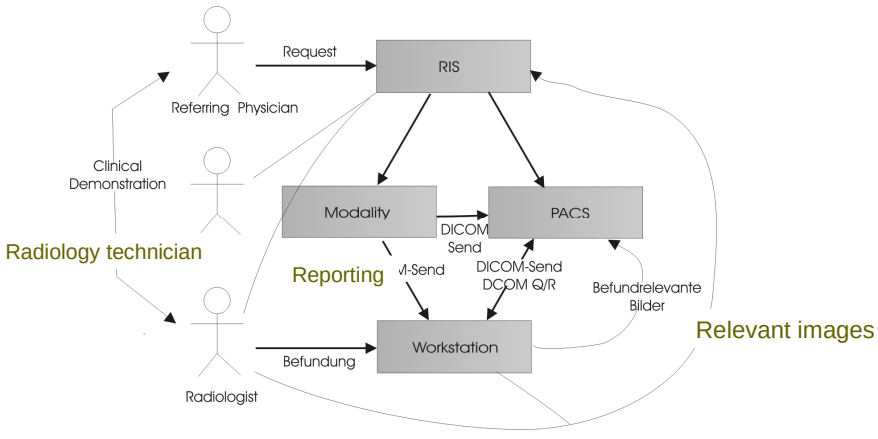
Outline

- Radiology Departments
- Storage of Medical Image Data
- Conventional Film-Based Diagnosis
- Soft-Copy Reading
  - Digital Hanging Protocols
  - Guidelines for Software Assistants
- 3D Visualizations in Radiology

Radiology Departments

- Large variety of imaging devices (CT, MR, Computed X-Ray, …)
- Large variety of output devices (printer, CRT-monitors with different spatial and grey-value resolution)
- Archival of image data in PACS-systems
  - Huge amounts of data
- Imaging devices, output devices, workstations and PACS are interconnected.

Radiology Departments



General radiological workflow

Image Courtesy Jens Breitenborn, MeVis Diagnostics

Radiology Departments

What are the consequences?

- Interoperability of devices from different manufacturers is essential.
- Standardized format and description of image data is essential.
- Data protection, security and reliable identification of patient and body part, e.g. left leg
- „Correct“ or optimal display at different output devices is essential.

Storage of Medical Image Data

- DICOM (Digital Imaging and Communications in Medicine)
- Established by NEMA (National Electronics Manufacturer‘s Association) in 1993
- Enables digital communication between imaging devices, information systems and referring physicians (other dept.s of the hospiatl or external)
- Enables exchange of data between devices from different manufacturers

Storage of Medical Image Data

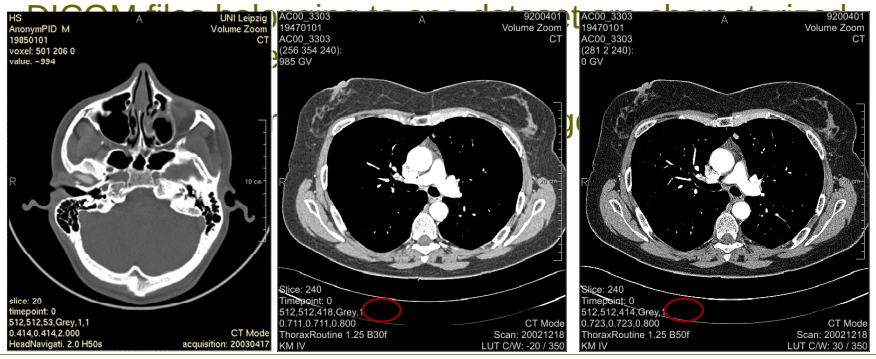
Scope of DICOM

- 18 parts, some 2000 pages
- 26 working groups discuss extensions
- Working group 24: Surgical DICOM
- Questions, such as: How to represent 3D meshes in DICOM including different representations of an object, application of textures, etc?

Storage of Medical Image Data

CT and MRI Data in DICOM

- A series of individual DICOM files, each representing a slice.
- DICOM files [illegible]
- [illegible]



Storage of Medical Image Data

Mandatory and optional *tags* summarized to *groups*

- *Patient data:* Name, birth date, sex, optional: weight
- *Image data:* study-id, series number, image group
- *Image presentation*: slice distance, pixel spacing, default presentation (window width, window height)
- *Acquisition parameters*: sequence name, special description, reconstruction filter, position and

Conventional Film-based Diagnosis

Why is it important?

- Radiologists are accustomed to this proces. Digital processes should be somehow „similar“.
- Radiologists are extremely efficient in film-based diagnosis. Digital processes must be at least that efficient.
- Radiologists cooperate with radiology technicians and focus on the high-level tasks. Thus, the perspective of the radiology technicians is also essential for adopting digital solutions.

Conventional Film-based Diagnosis

Important aspects:

- Radiologist and radiology technician closely cooperate
- Radiologist decides which m
  parameters are used
- Radiology technician perfor
  procedure, operates the dev
  arranges and prepares the i
  data for the diagnosis (readi

Image courtesy Sebastian Mayer
MeVis Diagnostics

Conventional Film-based Diagnosis

Result:

- Written report, e.g. using voice recorder
- Complex cases: Demonstration for the referring physician and/or interdisciplinary discussion, e.g. tumor board

Digital solutions should support these processes!

Conventional Film-based Diagnosis

- Magnifying glasses are used intensively.
- Simultaneous reading of „old“ and „new“ images
- Simultaneous reading of different slices or different orientations
- Careful and efficient arrangement of image data
- Plenty of space for viewing
- Films: High spatial and gray level resolution

Drawbacks:

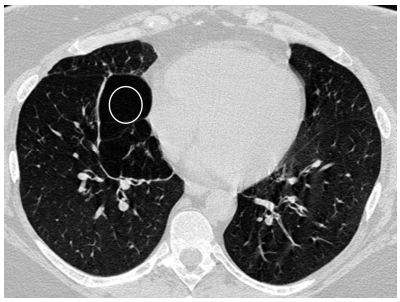
Soft-Copy Reading

Special monitors with high spatial resolution (2000x2500 pixels) and high gray value resolution (10 bit) are used for reading X-ray images.

Image Courtesy, MeVis BreastCare

- Layout corresponds to the habits in conventional film-based

Soft Copy Reading



Quantitative analysis of gray values in a ROI for assessing the severity of diseases, such as emphysema and fibrotic disease and bone mineral density (osteoporosis)

- Analysis of cross-sectional areas (severity of a

3D Visualizations

- Are rarely used at all.
- Radiologists are trained very well to infer spatial relations from cross-sectional images.
- Support an overview, not an in-depth analyis
- Primarily in case of rare anatomic variants, complex fractures and whenever the referring physician requires it.
- The radiologist „only“ describes the data: insight understanding of the anatomy is often not required.

Preferred viewing modes:

- Maximum-intensity projection

3D Visualizations

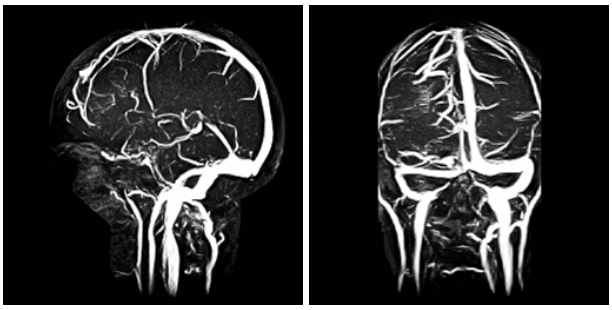


Image Courtesy
B. Terwey, Bremen

MIP renderings of cerebral MR angiography data. Diagnostic task: search for vascular malformations, e.g. aneurysms

3D Visualizations

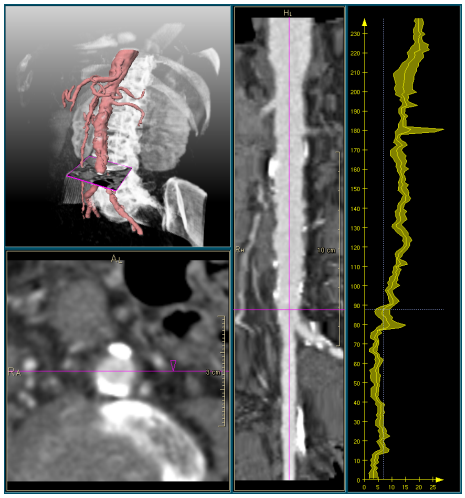


Image Courtesy Tobias
Boskamp, MeVis Research

3D Visualizations

Image Courtesy Volker Dicken, MeVis Research

Thin Slab-Rendering of CT thorax data. Diagnostic task: search for lung nodules (suspicious of being malignant)

3D Visualizations

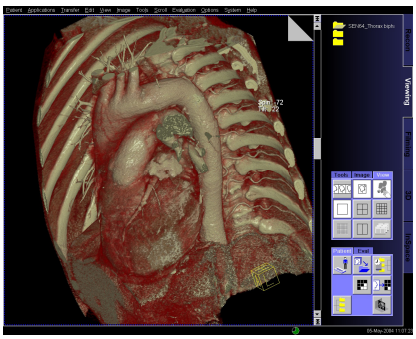
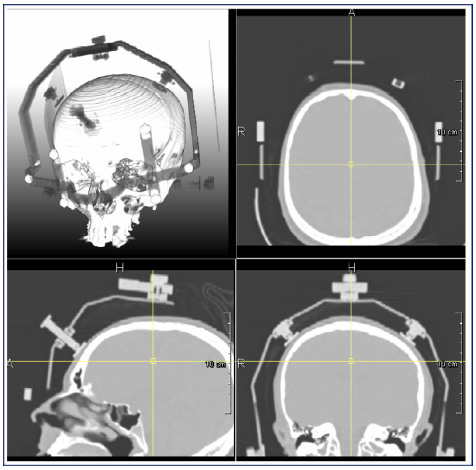


Image Courtesy, SIEMENS Medical Solutions

Volume rendering with pre-defined transfer functions (gallery concept) based on high-resolution image data.

3D Visualizations



Synchronized combinations of 2D and 3D visualizations are useful for treatment planning.

Summary

- The introduction of new techniques in radiology requires careful integration in the infrastructure of radiological departments.
- DICOM is essential, also for communicating results.
- Analysis of conventional film-based diagnosis is inspiring.
  - Try to improve on the drawbacks, but also to maintain the positive aspects.
- Talk to users, analyze their needs and distinguish

Links

- Integrating the health care enterprise
  http://www.ihe.net/
- DICOM http://medical.nema.org/
- DICOMscope - DICOM-Viewer
  http://dicom.offis.de/dscope.php.de
- David Clunie's dicom3tools
  http://www.dclunie.com/dicom3tools.html