

Chapter 1

Medical images, unlike photography:

- X-ray Absorption: Medical images show things by seeing how much X-rays are absorbed, not by reflecting light.
 - Exact Object Delineation: They're more about clearly showing what's there, not just detecting shapes.
 - Variations in Shape and Appearance: They capture differences in how things look for evaluation.
 - Analysis Methods: They focus on techniques like making things clearer, fixing them up, making them better, and matching them together.
 - Fusing Images: They're about combining images from different places, not just figuring out what's in them or making 3D models.
- A. Delineation: Drawing clear lines around objects in an image.
 - B. Restoration: Fixing or improving the quality of an image.
 - C. Enhancement: Making an image clearer or more detailed.
 - D. Registration: Aligning and merging multiple images together.

Analysis of medical images:

- Computer-assisted analysis aids experts (radiologists, surgeons) in decision-making.
- Different analysis tasks correspond to specific decision needs:
 - Delineation (segmentation task): Defining object boundaries.
 - Detection (classification task): Identifying objects.
 - Comparison of object appearance (registration task): Aligning images from different times or modalities.

Image Analysis in Clinical Workflow:

1. Clinical Study: Doctors look at images to understand or confirm findings. They're usually put on a special computer.
2. Large Cohort Studies: Computers help analyze images because there are lots of people involved.
3. Computer Aided Diagnosis support: Doctors use computers to look at lots of images for one patient to help figure out what's wrong.
4. Treatment Planning: Doctors look at images before they start treating a patient.
5. Computer-Assisted Surgery: Images help doctors during surgery to make sure they're doing it right.

Table 1.1 Different scenarios for computer-assisted image analysis have very different requirements

	Cohort study	Clinical study	Computer aided diagnosis	Treatment planning	Computer-assisted surgery
No. of cases	Very large	Large	Small	Small	Small
Time-constraints	Low	Low	Medium	Medium	High
Location	Anywhere	Anywhere	Office, reading room	Office, ward	Operating room
Interaction	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable
Archival requirements	Very high	High	High	Medium	Medium

Using Tools in Medical Image Analysis:

A. Viewer Software:

- Used for accessing and examining image data.
- Helps organize data and discuss solutions with experts.
- Example: MicroDicom viewer for viewing DICOM images.

B. Analysis Software:

- Provides parameterizable analysis modules for various image analysis tasks.
- Examples: MevisLab for commercial and non-commercial use, offering intuitive interfaces.
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C. 3D Slicer:

- Open-source software for segmentation, registration, and analysis of medical images.
- Provides user interfaces for various modules and allows combining them for processing pipelines.

D. Rapid Prototyping Programming Language:

- MATLAB or IDL are interpreter languages suitable for rapidly processing image arrays.

Software Libraries:

- OpenCV for general image processing and computer vision tasks but lacks support for 3D or 4D scenes.
- ITK (Insight Toolkit) focuses on segmentation and registration of medical images, with extensive coverage of segmentation methods.