Medical Image Processing for Diagnostic Applications

Teaser – Modalities

Online Course – Unit 2

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Topics

Modalities for Medical Imaging

Definition

In medical imaging we call any of the various types of scanners used to acquire image signals of human organs a ***modality***.
If we speak about *modality* in general terms, we just mean a medical image acquisition device.

Definition

An image acquisition device that combines two or more modalities is called ***hybrid scanner*** or ***hybrid system***.

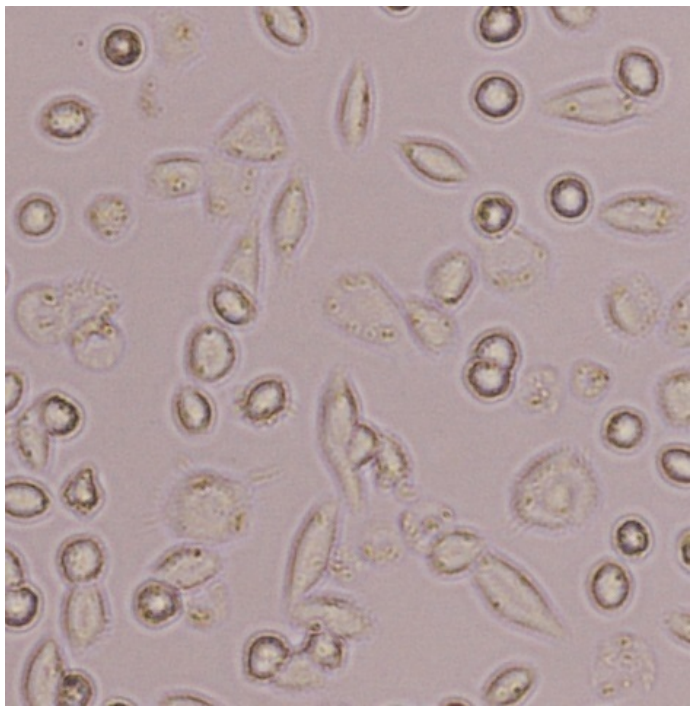
Modalities for Medical Imaging: Examples

The most commonly used modalities in medicine are:

- microscopes,
- endoscopes,
- cameras for retina imaging,
- optical coherence tomography (OCT),
- X-ray systems (X-ray),
- computed tomography (CT),
- magnetic resonance imaging (MRI),
- positron emission tomography (PET),
- single photon emission computed tomography (SPECT),
- ultrasound systems (US).

Modalities for Medical Imaging: Examples

Microscopes & endoscopes



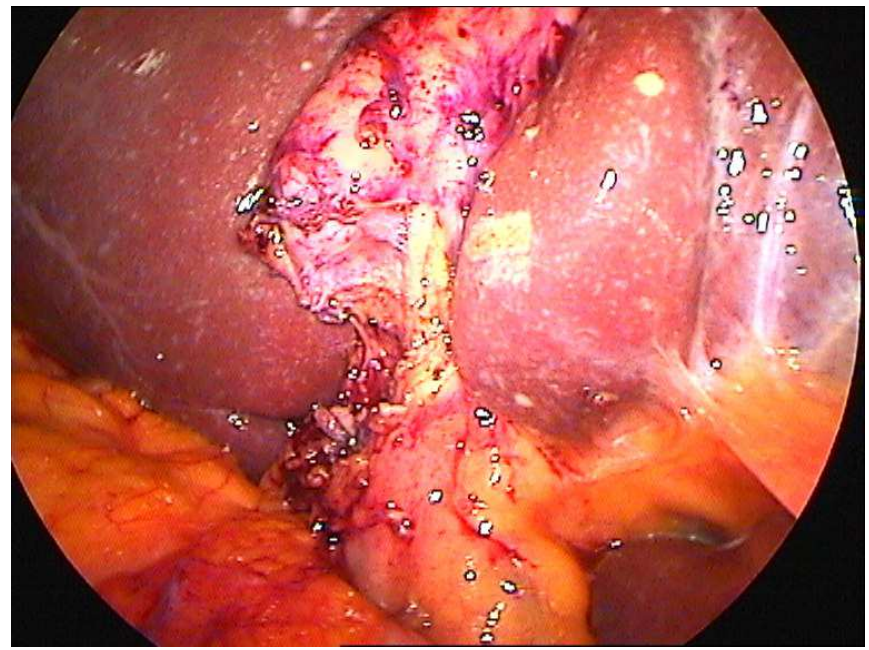


Figure 1: Microscopic and endoscopic images (Firas Mualla & Florian Vogt, Pattern Recognition Lab, FAU)

Modalities for Medical Imaging: Examples

Cameras for retina imaging & optical coherence tomography (OCT)

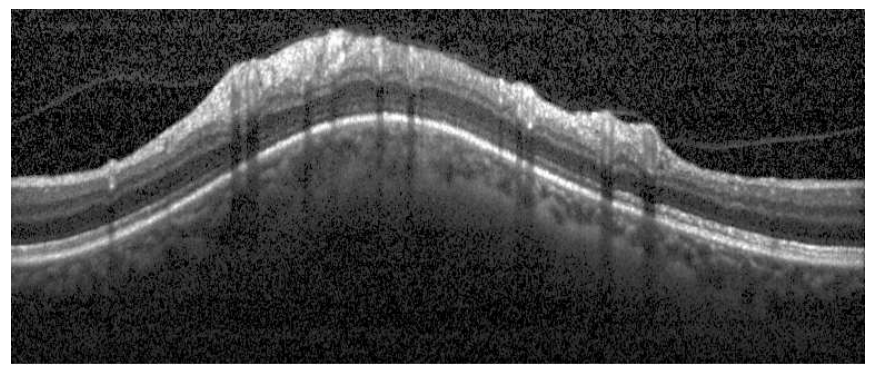


Figure 2: Retina images (Rüdiger Bock & Markus Mayer, Pattern Recognition Lab, FAU)

Modalities for Medical Imaging: Examples

X-ray systems (X-ray) & computed tomography (CT)

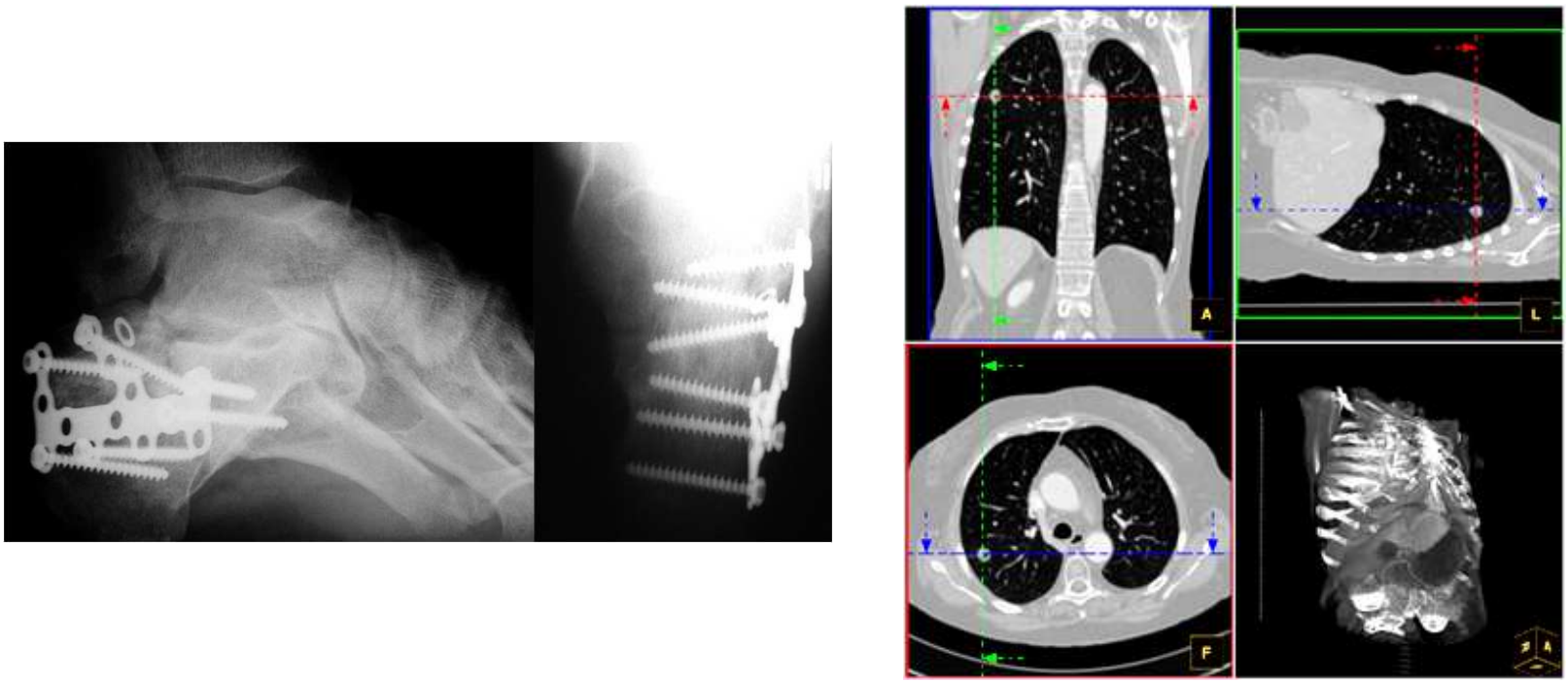
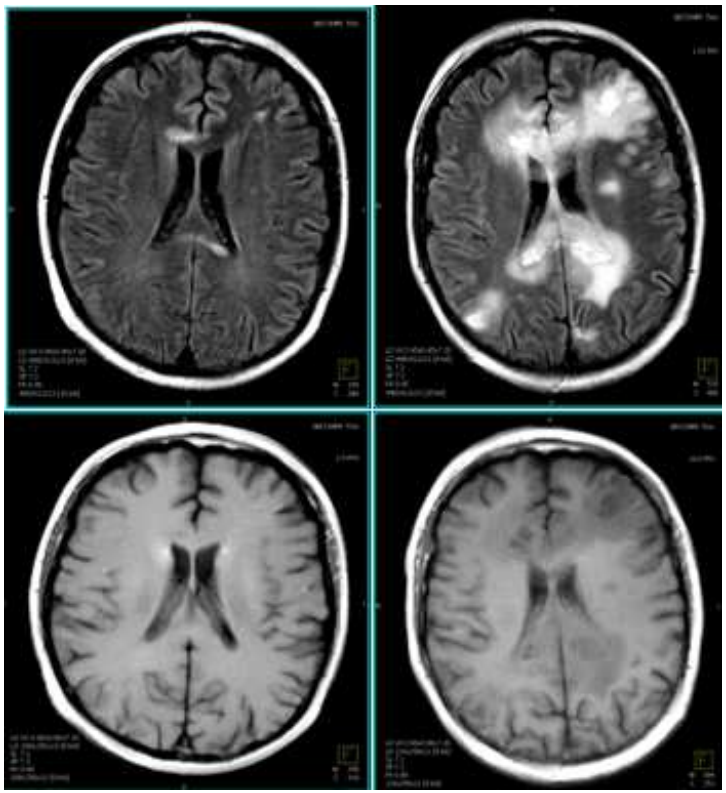


Figure 3: X-ray and CT images (Dieter Hahn, Pattern Recognition Lab, FAU)

Modalities for Medical Imaging: Examples

Magnetic resonance imaging (MRI)



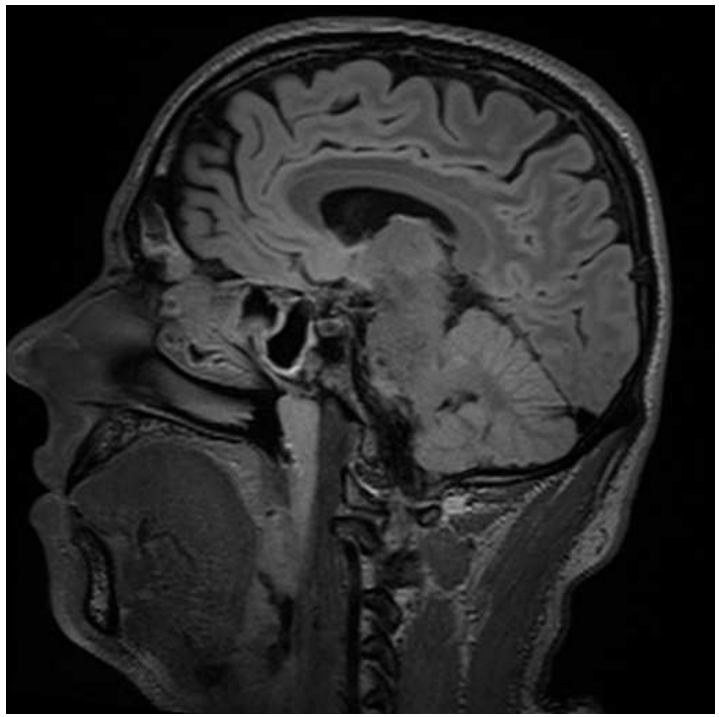


Figure 4: Brain MRIs (Links: Dieter Hahn & Florian Jäger, Pattern Recognition Lab, FAU)

Modalities for Medical Imaging: Examples

Single photon emission computed tomography (SPECT)
& positron emission tomography (PET)

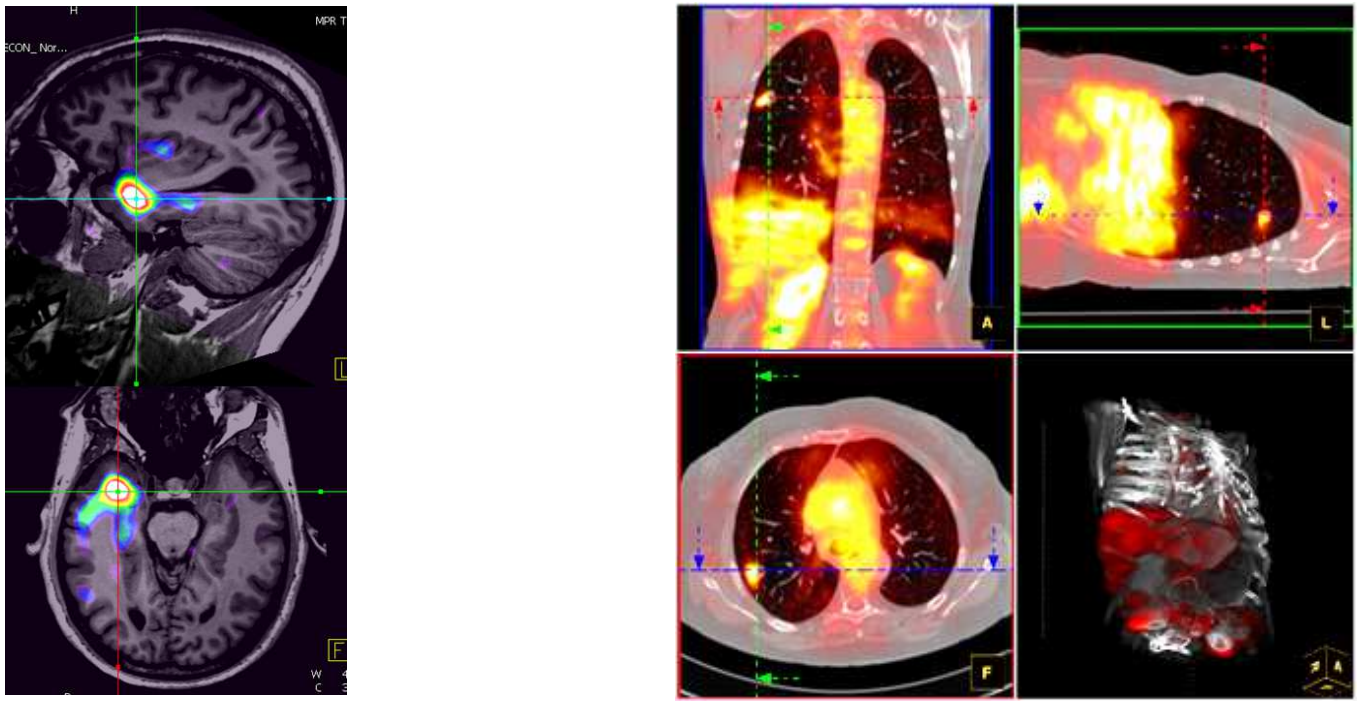
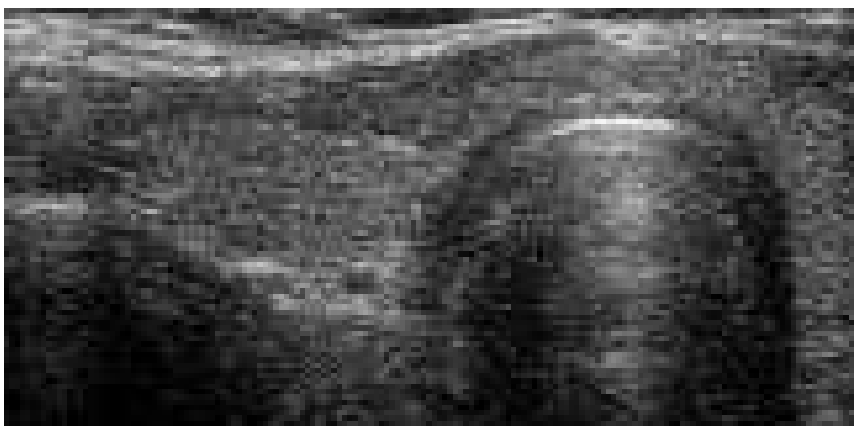


Figure 5: SPECT and PET overlays (James Sanders & Dieter Hahn, Pattern Recognition Lab, FAU)

Modalities for Medical Imaging: Examples

Ultrasound systems (US)



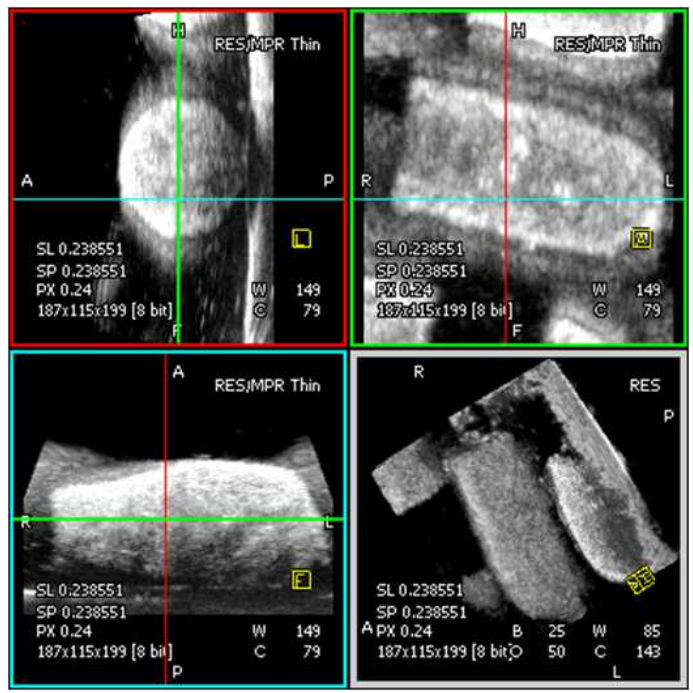


Figure 6: Ultrasound images (Eva Kollorz, Pattern Recognition Lab, FAU)

Hybrid Scanners for Medical Imaging

- The number of hybrid scanners on the market and in hospitals is increasing continuously.
- Themed to *"get the best of everything"*, modalities like PET-Scanners are no longer required as standalone systems but only in combination with morphologic imaging modalities, like CT.

Figure 7: First European installation of a SPECT/CT-Scanner (Image courtesy of Prof. Kuwert, Nuclear Medicine, FAU)

Hybrid Scanners for Medical Imaging

Commercially available hybrids are:

- 2-D/3-D endoscopy,
- SPECT/CT scanner,
- PET/CT scanner,
- PET/MR scanner.

Figure 7: First European installation of a SPECT/CT-Scanner (Image courtesy of Prof. Kuwert, Nuclear Medicine, FAU)

Topics

Take Home Messages

- We heard about the concepts of different imaging modalities.
- We also learned that there are hybrid scanners which combine different modalities to benefit from their all their imaging characteristics.

Further Readings

An introduction to the physics for medical imaging is given by the following books:

1. David J. Dowsett, Patrick A. Kenny, and R. Eugene Johnston. *The Physics of Diagnostic Imaging*. 2nd ed. London: Hodder Arnold, Apr. 2006. DOI: 10.1201/b13462-1
2. Arnulf Opelt, ed. *Imaging Systems for Medical Diagnostics: Fundamentals, Technical Solutions and Applications for Systems Applying Ionizing Radiation, Nuclear Magnetic Resonance and Ultrasound*. 2nd ed. Erlangen: Publicis, 2005

The mathematical details of medical imaging are described in:

Charles L. Epstein. *Mathematics of Medical Imaging*. Upper Saddle River, N.J.: Pearson Education/Prentice Hall, 2003