Preliminaries

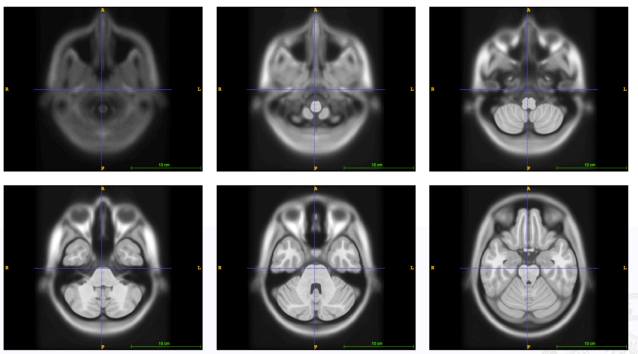
Topics covered in this lecture:

- Radiography (X-Ray & CT)
- Magnetic Resonance Tomography (MRT)
- Ultrasound
- Time-of-Flight (ToF)
- Structured Light
- LIDAR

In other words, this lecture is about imaging modalities **beyond typical "consumer electronics"**.

Imaging Modalities

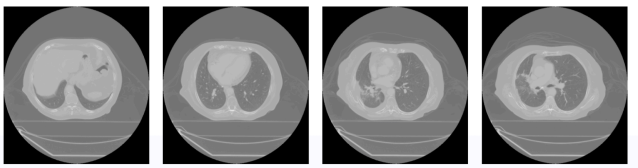
Magnetic Resonance Tomography



Brain MRT

Note: Physical environment (temperature, scanner parameters, etc.) has a huge impact on the captured image. This might result in totally different images of the same person.

Computer Tomography



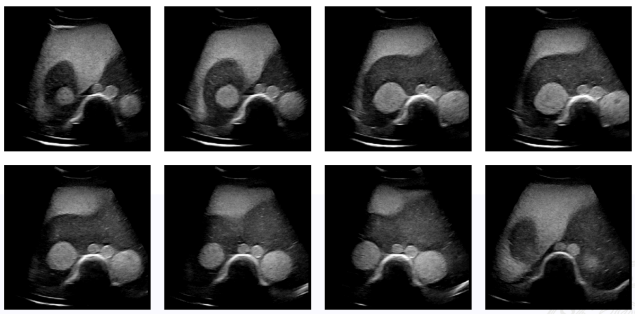
Lung CT

Note: Captured by "rotating X-Ray".

Problem with CT:
Ionizing ("ionisierend") radiation is typical used for "bone-like" structures. It's hard to differentiate between

many different tissue types. MRT performs much better in these types of scenarios.

Ultrasound



Freehand US of a phantom

Structured Light

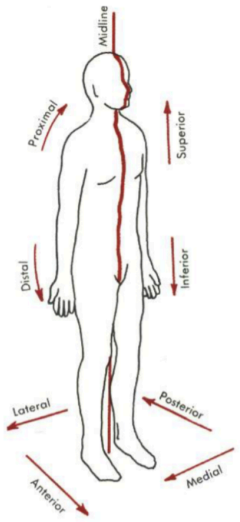
MS Kinect

We get two different types of information:
- Point Cloud
- Depth Map

Intensity values

Intensity values are related to physical tissue characteristics.
So, we can say that the actual voxel value in medical imaging has more meaning that in standard imaging.

Anatomical Orientations



- Superior vs. Inferior
- Right vs. Left
- Anterior vs. Posterior

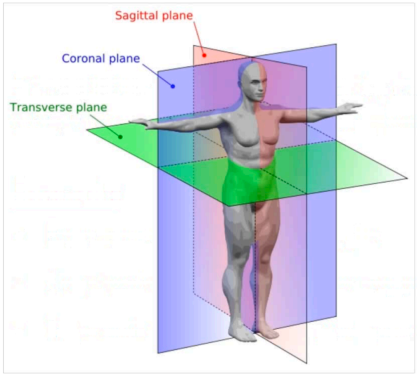
Note that "Left/Right" is seen from the view of the patient.

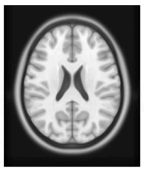
Orientations are typically encoded in a three letter code. We need to be really careful since different images often have totally different letter codes!

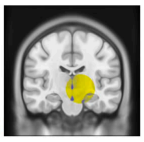
The code always describes to positive direction of each axis!

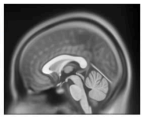
Example: RAS
R: x-axis from left to right
A: y-axis from posterior to anterior
S: z-axis from interior to superior

Imaging Planes




Transverse/Axial


Coronal


Sagittal

Coordinate Space

We have multiple coordinate systems:

- **World:** How the patient was "lying" within the scanner.
- **Anotomical:** Coordinate system with respect to the planes
- **Image:** Coordinate system of the image

Note: In some cases we have to go back from the image coordinate system to the world coordinate system.

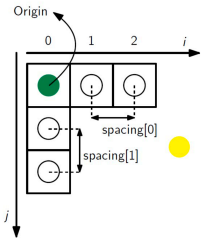
For instance, if we have a robot which operates a patient (e.g. rain surgery)

Image Origin
Position of the first voxel in the anatomic coordinate space.

origin = [100mm, 50mm, -10mm]

Voxel spacing
Distance between voxel.

spacing = [1mm, 1mm, 0.9mm]



Note: If want to see a lot of details (very small structures), we need a fine spacing. Otherwise we are not able to capture all the details.

What's a imaging phantom?

Imaging phantom, or simply phantom, is a specially designed object that is scanned or imaged in the field of medical imaging to evaluate, analyze, and tune the performance of various imaging devices. For example, we can use a phantom to calibrate your device.