



Pattern Recognition in 3D Imaging

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Pattern Recognition Lab

Friedrich-Alexander-Universität Erlangen-Nürnberg

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Introduction



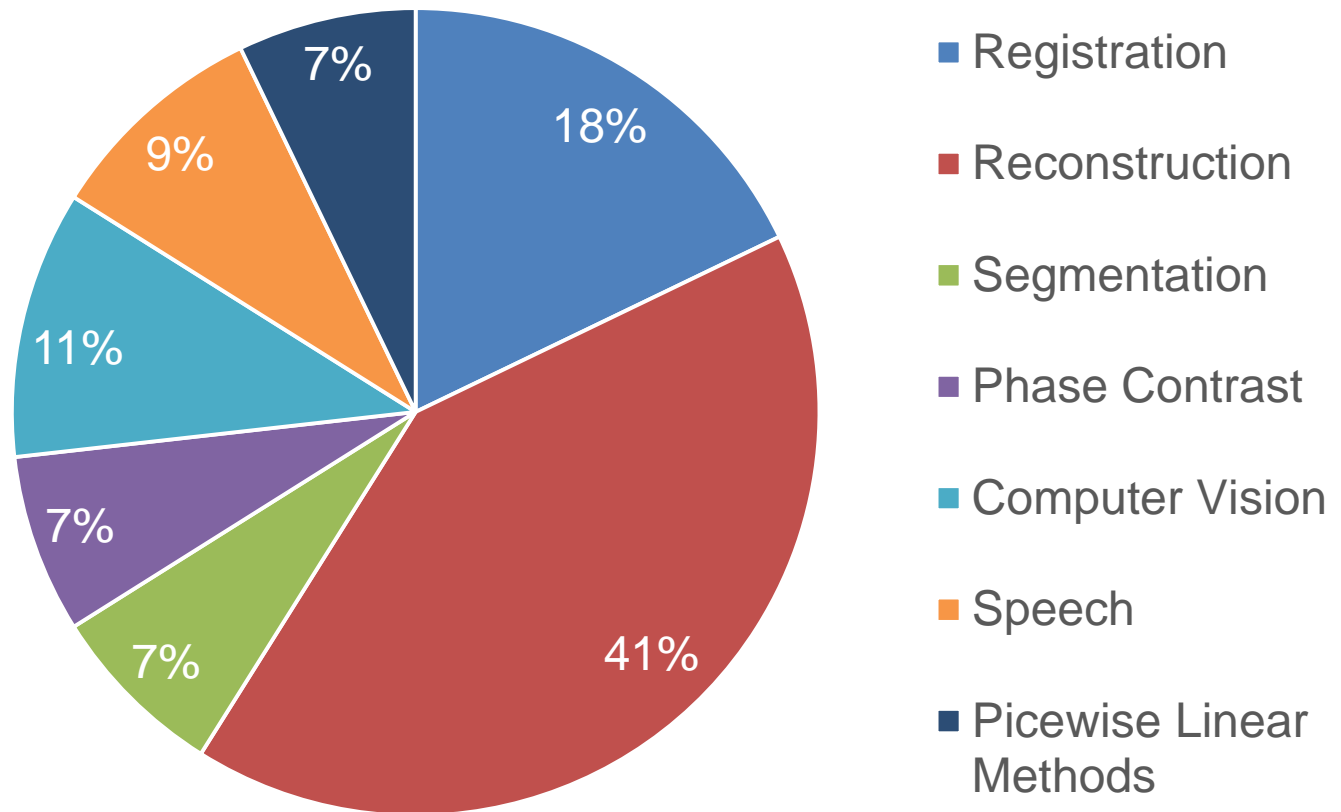
Pattern Recognition Lab

- Founded in 1975
- Located in the computer science department (school of engineering)
- Our team:
 - 5 professors
 - 2 lecturers
 - 5 Post-docs
 - 55 PhD students
 - 4 admins



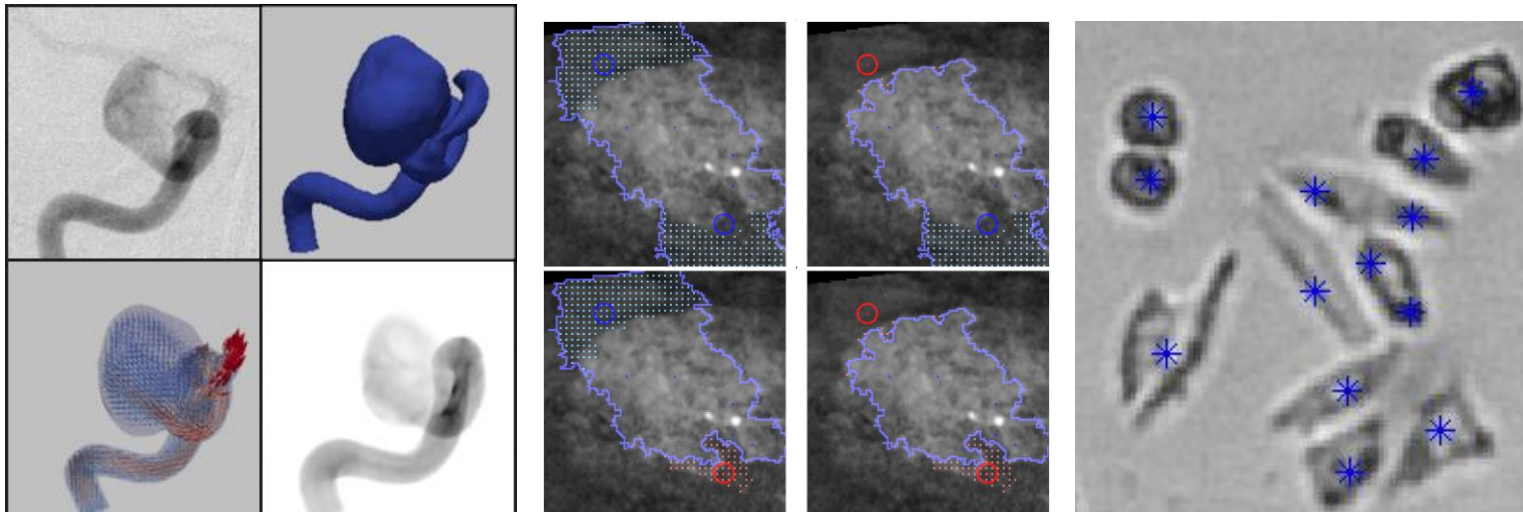
Pattern Recognition Lab

Research groups at the lab:



Medical Image Segmentation

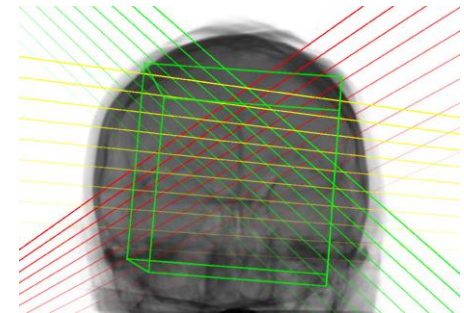
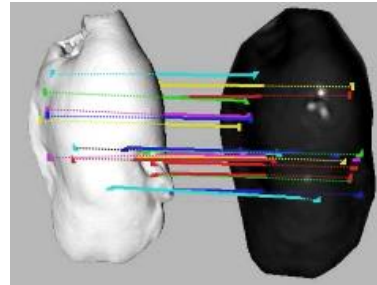
- Vessel segmentation
- Computational fluid dynamics (CFD) simulation
- User-driven liver segmentation
- Cell detection and segmentation in microscopy



Medical Image Registration

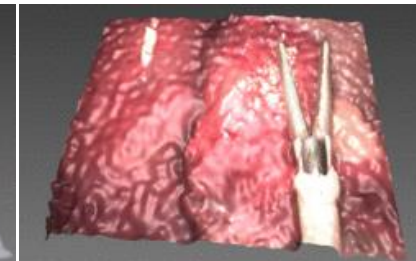
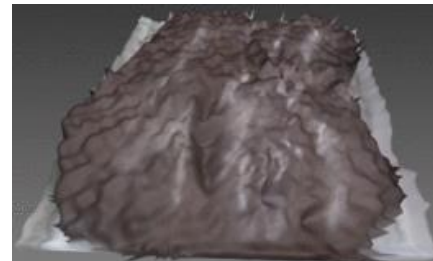
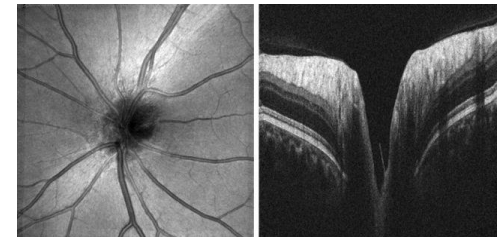
- Methods:

- Rigid & non-rigid registration
- Interventional registration
- Surface registration
- Epipolar consistency



- Applications:

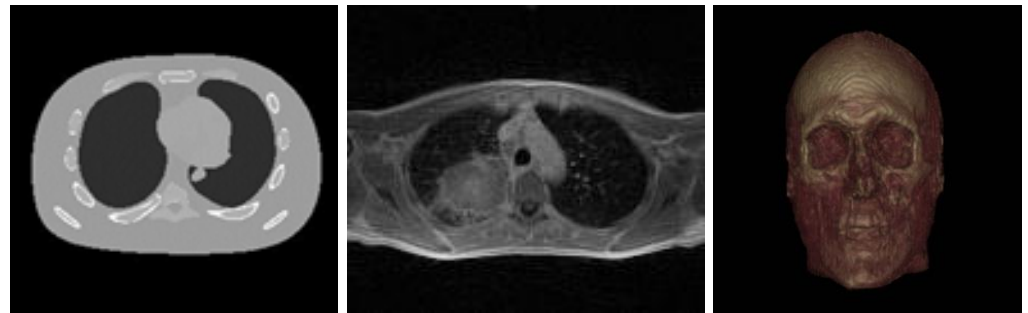
- Retinal imaging for ophthalmology
- Image-guided surgery
- Radiation therapy
- Radiology



Medical Image Reconstruction

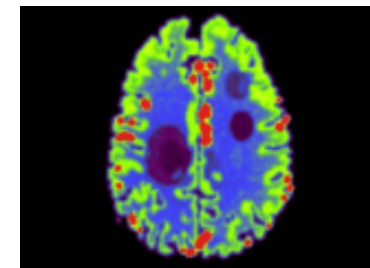
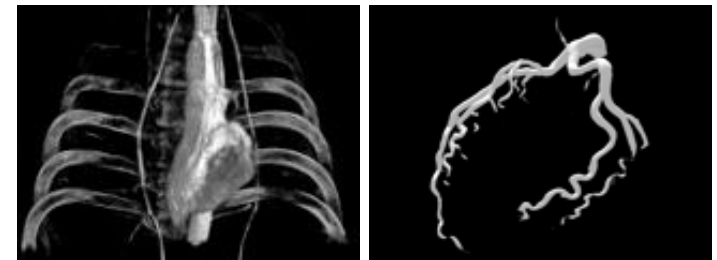
- Methods:

- CT/MRI reconstruction
- Molecular/hybrid imaging
- Image quality improvement
- Deep learning



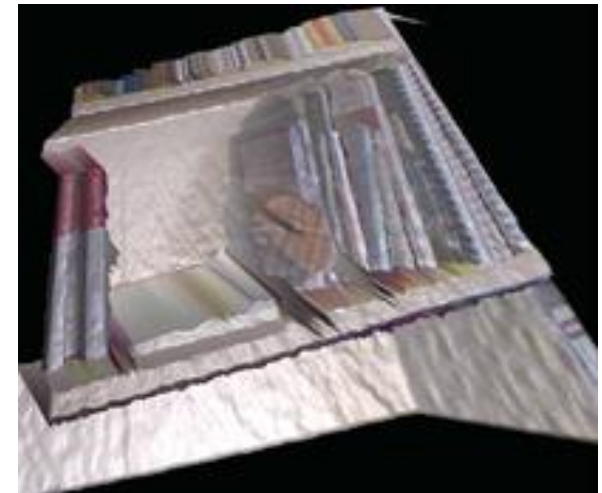
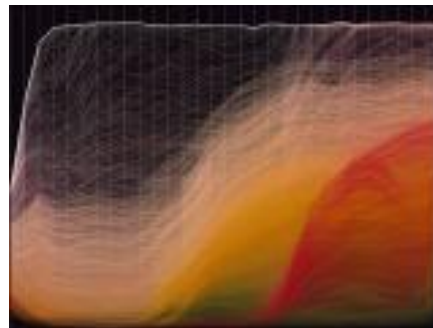
- Applications:

- Cardiac imaging with C-arm CT
- Perfusion imaging with C-arm CT
- Weight-bearing reconstruction



Computer Vision

- Writer identification in historical documents
- Hyperspectral imaging
- 3-D range imaging (Time-of-Flight)



Knee Imaging and RSA



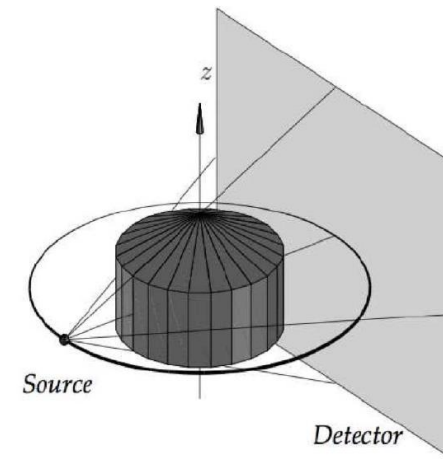
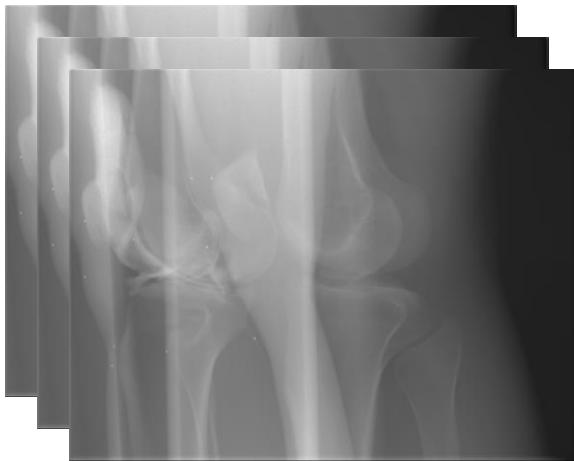
Knee Imaging Under Weight-Bearing Conditions



- **Aim:** measure cartilage deformation over time

Basics: Cone-Beam CT Reconstruction

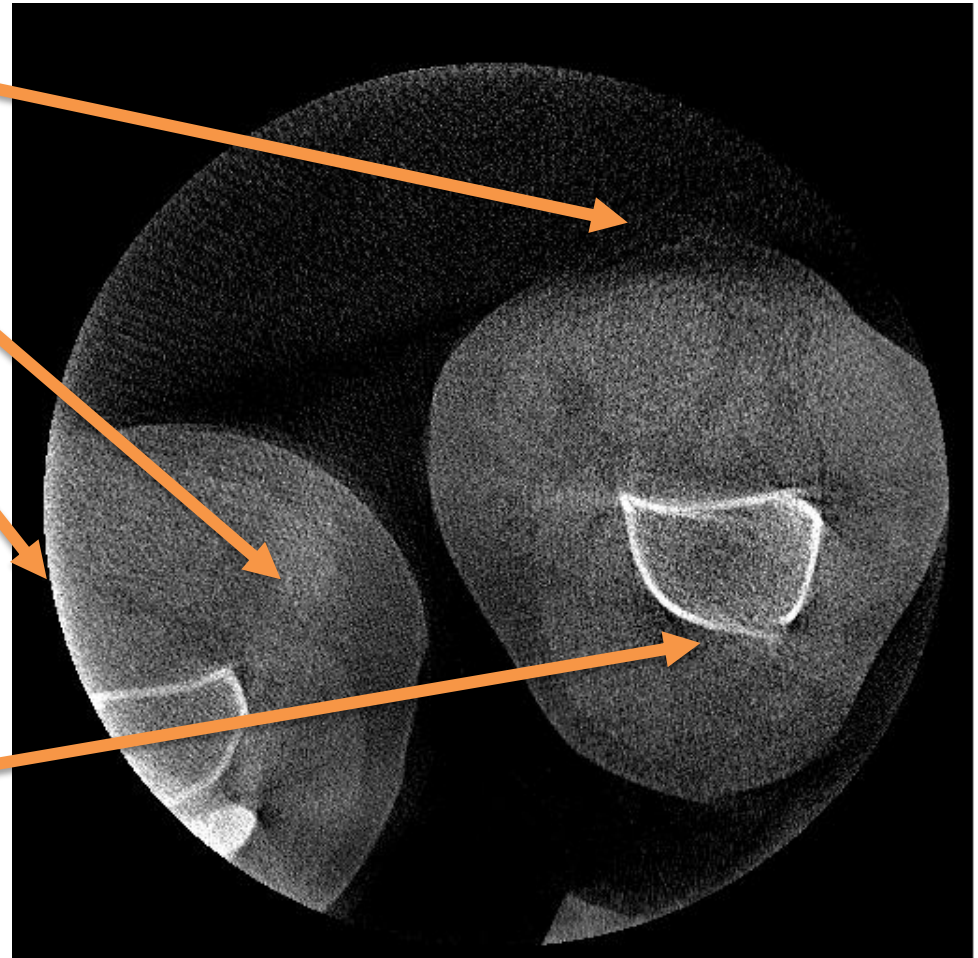
- Source and detector rotate around object and acquire multiple 2D x-ray images



- Known projection matrices from calibration
→ **Backprojection** (and some filtering) of the 2D images

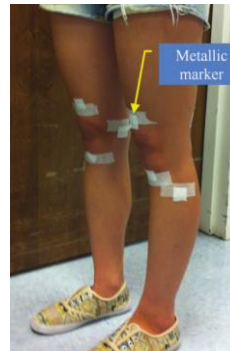
C-Arm Cone-Beam CT Reconstruction Problems

- Saturation
- Beam hardening
- Truncation
- Metal artifacts
- Scatter
- **Patient Motion**
 → Motion Artifacts



Motion Correction Using Markers

1. Attach metallic markers



2. Detect them in the 2D projection images

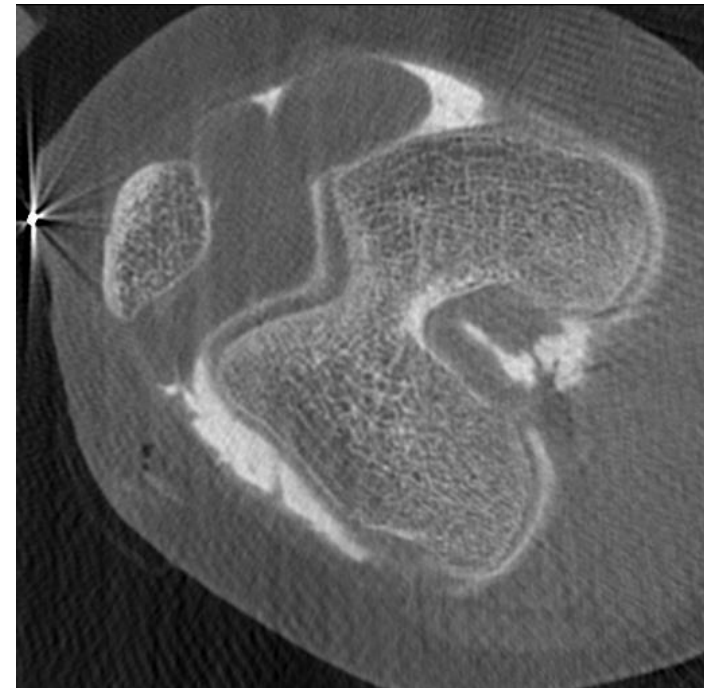
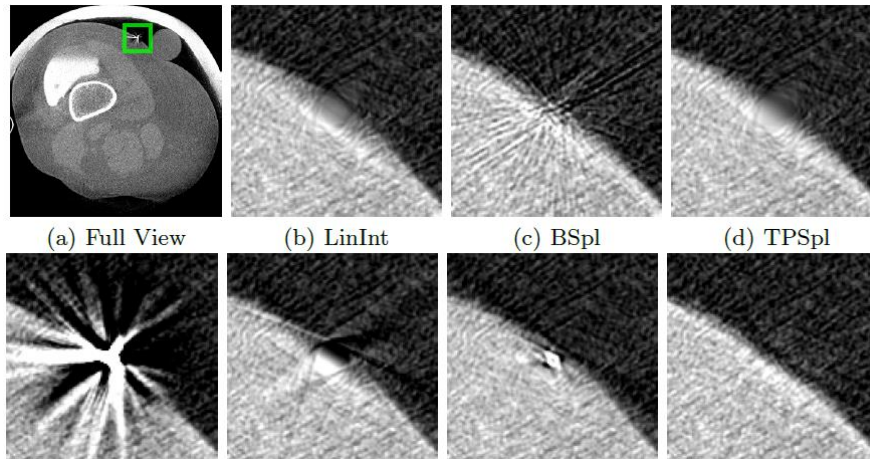
3. Compute their 3D reference position

4. Estimate 6D rigid motion



The Markers are Making Trouble

- Tedious to place
- Overlap
- Time consuming
- **Metal artifacts**



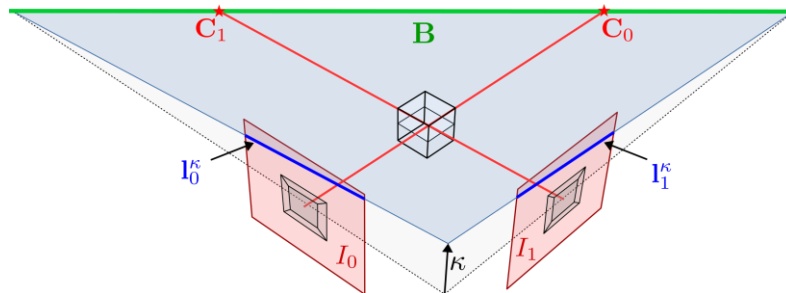
Current Research: Marker-Free Approaches

2D/3D bone registration

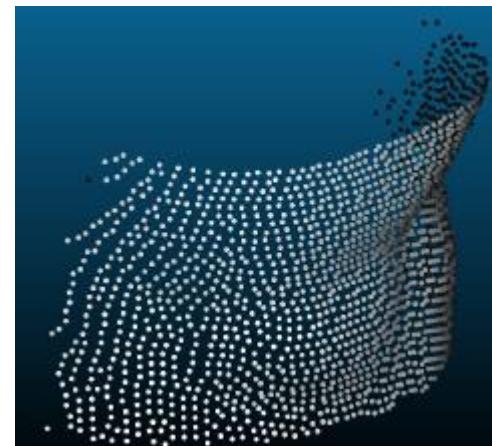
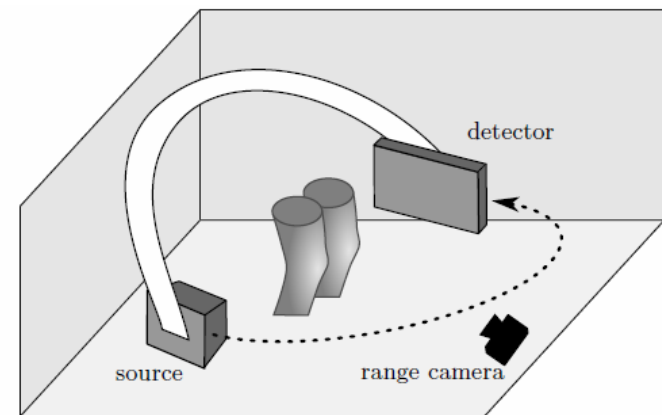
- use 3D segmented bones
- motion field for every bone



Epipolar consistency



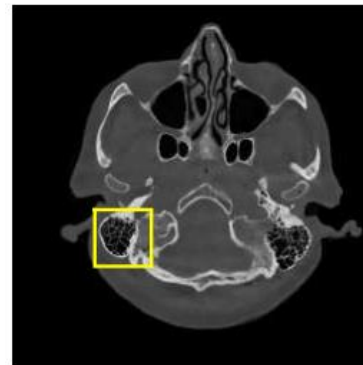
Range imaging



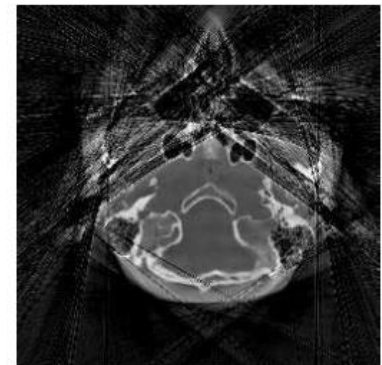
Outlook: Ideas for RSA

Direction of future research:
Reconstruction-based RSA

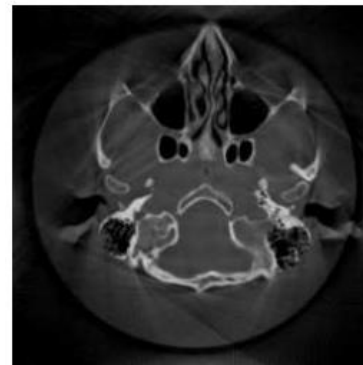
- Problem: Photon starvation
- Novel reconstruction techniques to enable marker-free RSA
 - Mixed 1 Bit Compressed Sensing
- Registration with CAD reference models
 - 2D/3D using X-ray images
 - 3D/3D using reconstructions



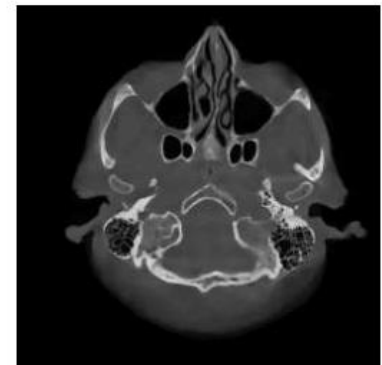
(a)



(b)



(c)



(d)

Thank you very much for your attention

Questions?

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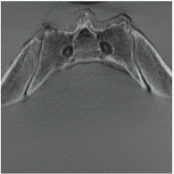
Computer Science Department 5

Researchers and students at [Pattern Recognition Lab \(LME\)](#) work on the development and implementation of algorithms to classify and analyze patterns like images or [speech](#). The research is mostly interdisciplinary and is focussed on medical- and health engineering. The [LME](#) has close national and international [collaborations](#) with other universities, research institutes and industrial partners.

A summary of the projects at the [Pattern Recognition Lab](#) is available for download as a [comprehensive brochure \(PDF\)](#).


Research Areas

Medical Image Processing



The division medical image processing investigates problem statements in → [image registration](#), → [reconstruction](#), → [segmentation](#), → [X-ray phase contrast](#) and image analysis.


Computer Vision



The computer vision division treats the topics of reflectance analysis, forgery detection, driver assistance and optical surface measurements.


Speech Processing and Understanding

Cooperations



LME-News

Mecuris sold world's 1st 3D-printed prosthetic feet with medical approval



Munich-based medical technology company Mecuris just shipped the world's first 3D-printed prosthetic feet bearing a CE mark. Specialising in personalised and additively manufactured orthopaedic patient aids, Mecuris offers an... [\[more\]](#)

Two prizes "Beste Wissenschaftliche Arbeit" and "Beste Präsentation" at BVM 2017

<https://www5.cs.fau.de/>

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