FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG
FACULTY OF ENGINEERING

Pattern Recognition in 3D Imaging

Bastian Bier, Thomas Köhler, Andreas Maier

Pattern Recognition Lab

Friedrich-Alexander-Universität Erlangen-Nürnberg

12. April 2017

FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

FACULTY OF ENGINEERING

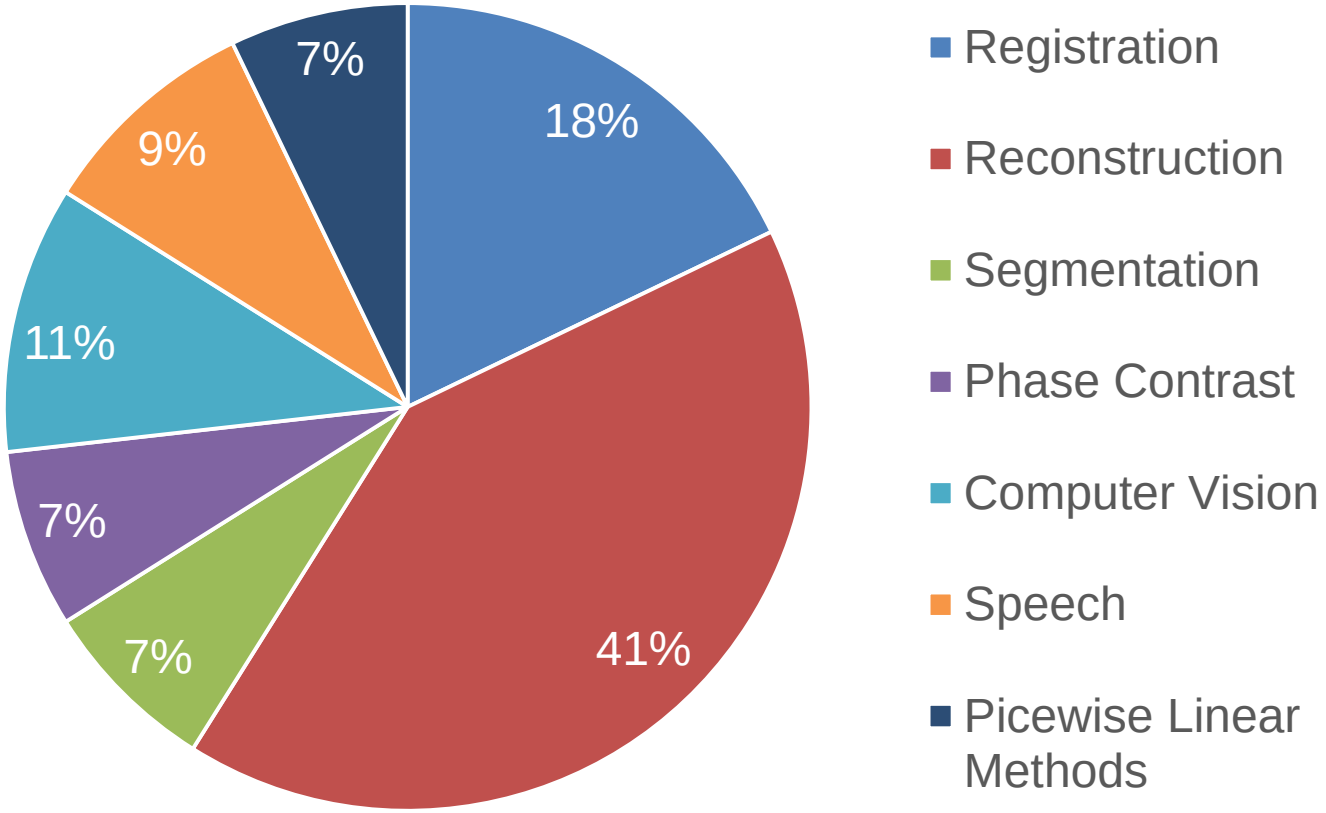
Introduction

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

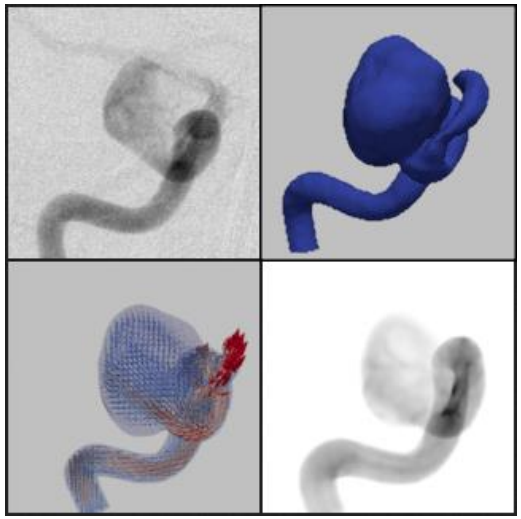
Pattern Recognition Lab

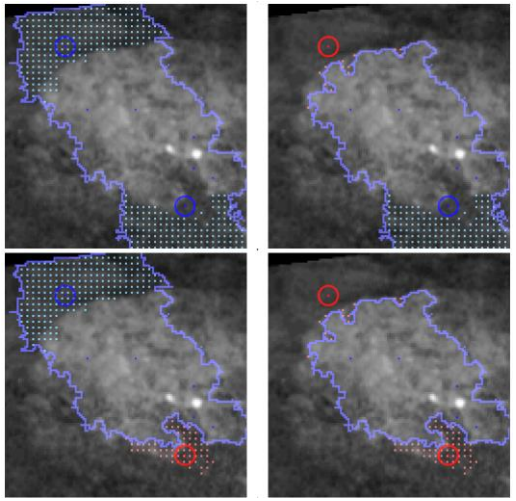
Research groups at the lab:

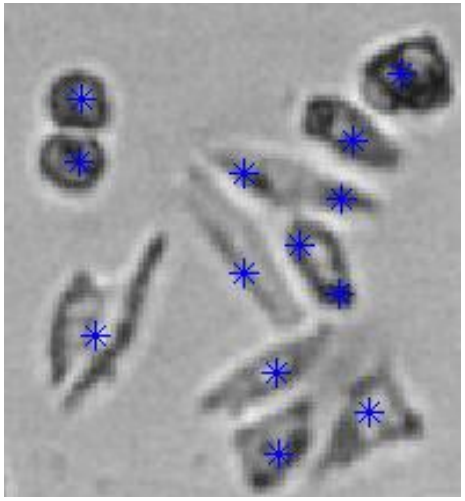


Medical Image Segmentation

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

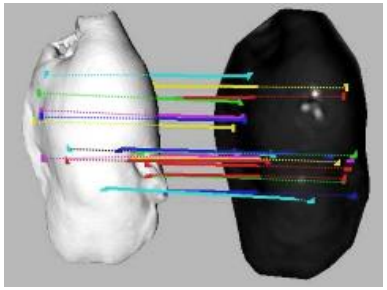


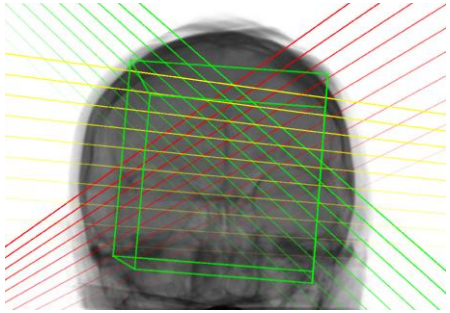




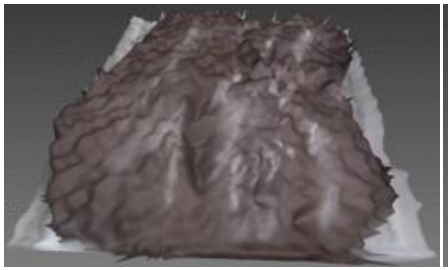
Medical Image Registration

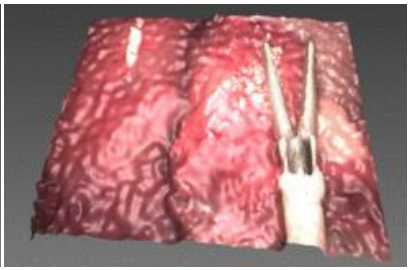
- Methods:
  - Rigid & non-rigid registration
  - Interventional registration
  - Surface registration
  - Epipolar consistency





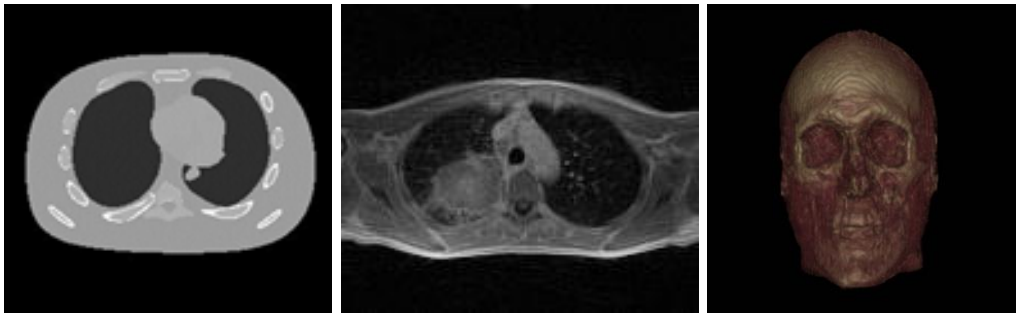
- Applications:
  - Retinal imaging for ophthalmology
  - Image-guided surgery
  - Radiation therapy
  - Radiology



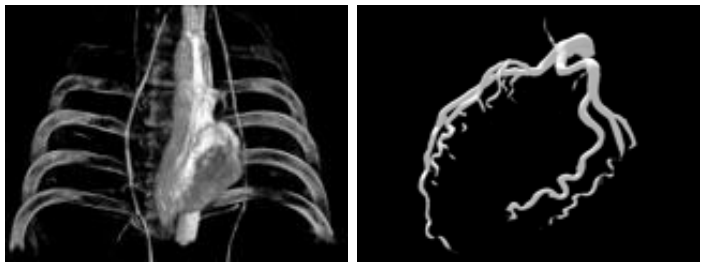


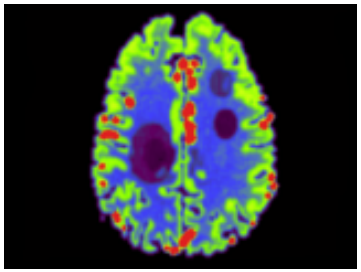
Medical Image Reconstruction

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



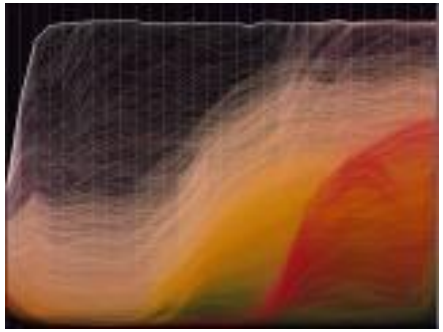
- Applications:
  - Cardiac imaging with C-arm CT
  - Perfusion imaging with C-arm CT
  - Weight-bearing reconstruction

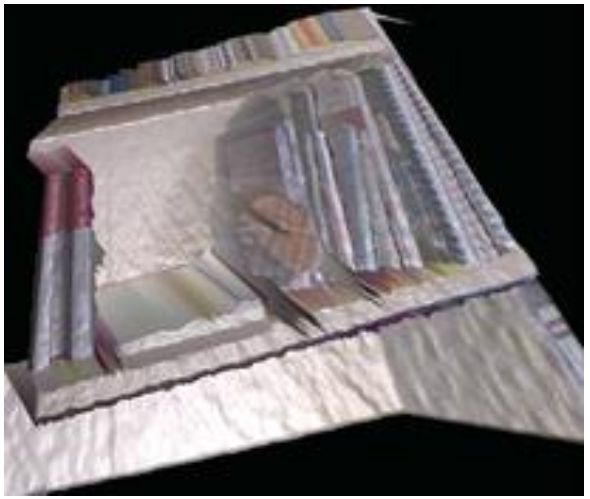




Computer Vision

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





FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

FACULTY OF ENGINEERING

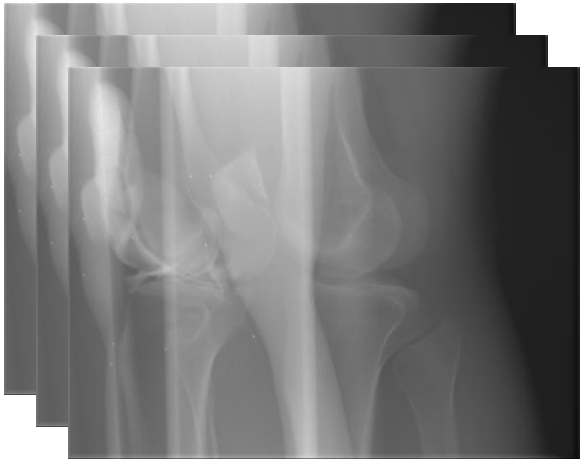
Knee Imaging and RSA

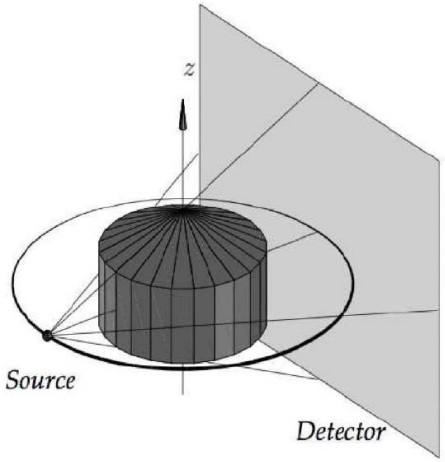
Knee Imaging Under Weight-Bearing Conditions

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

Basics: Cone-Beam CT Reconstruction

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





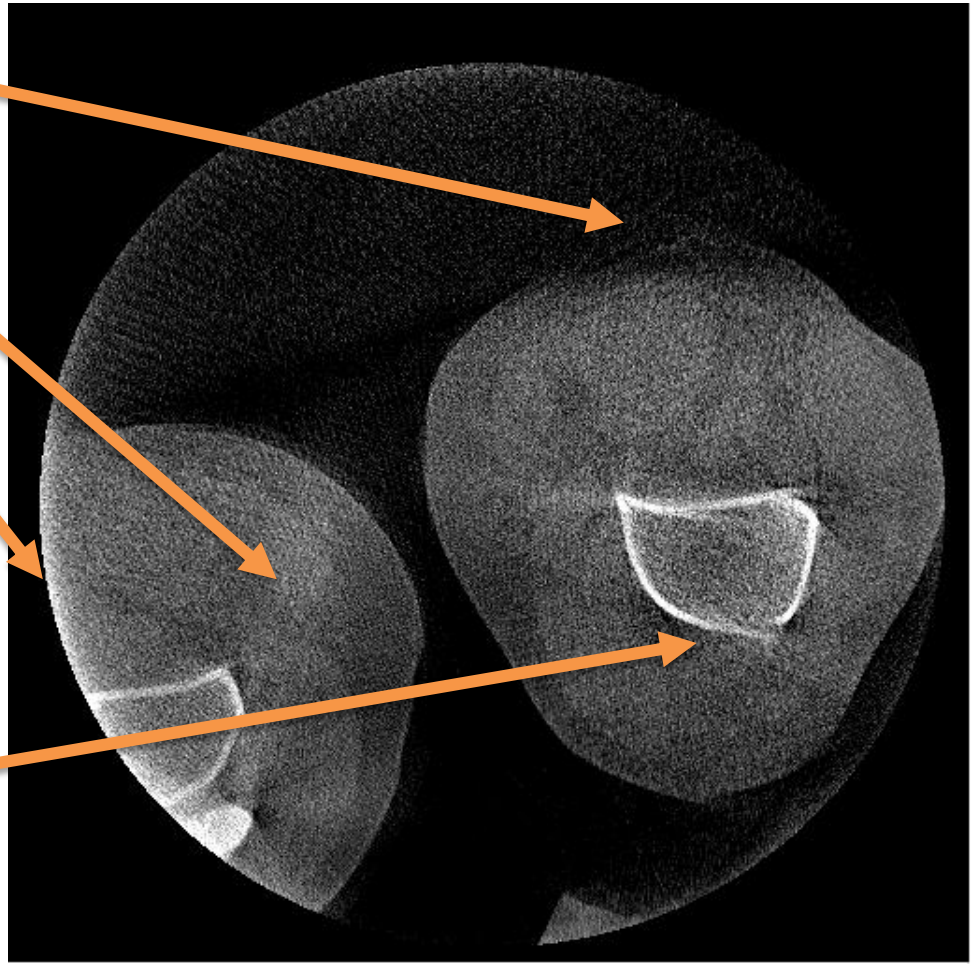
- Known projection matrices from calibration

  →**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

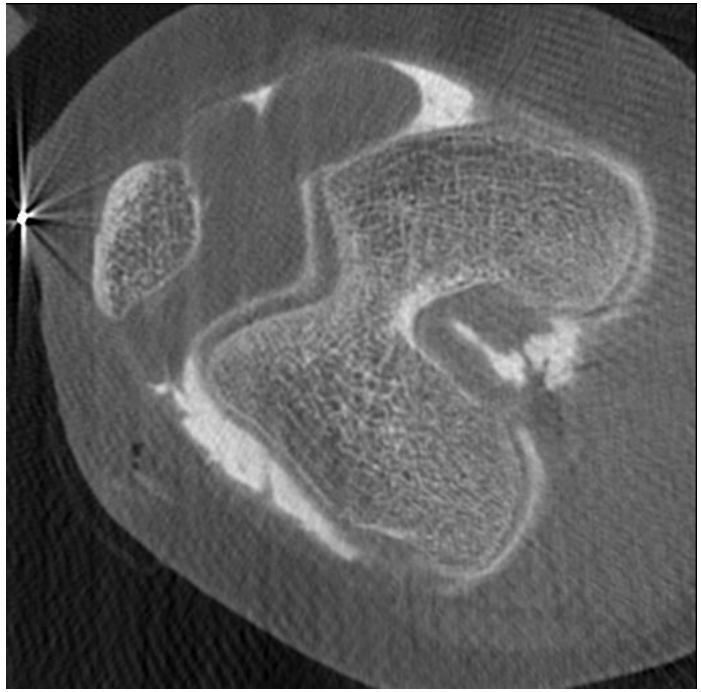
3. Compute their 3D reference position

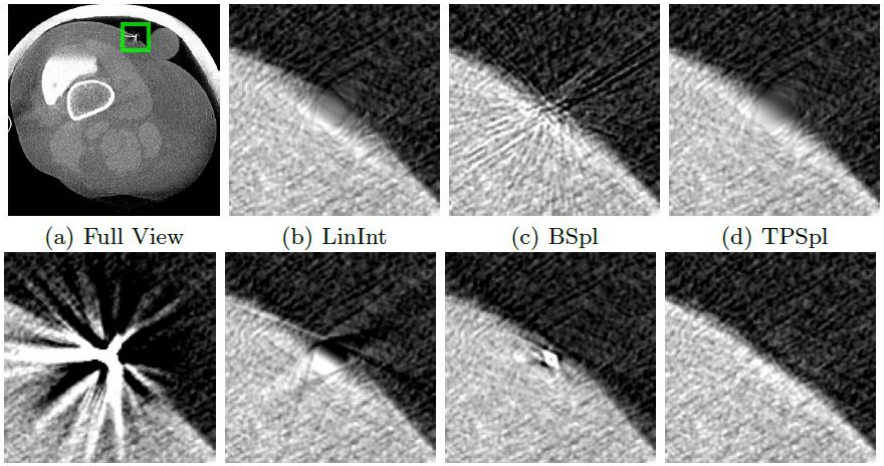
4. Estimate 6D rigid motion

The Markers are Making Trouble

- Tedious to place
- Overlap
- Time consuming

- **Metal artifacts**



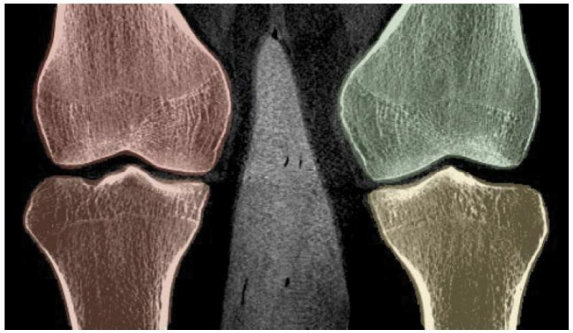


(a) Full View (b) LinInt (c) BSpl (d) TPSpl

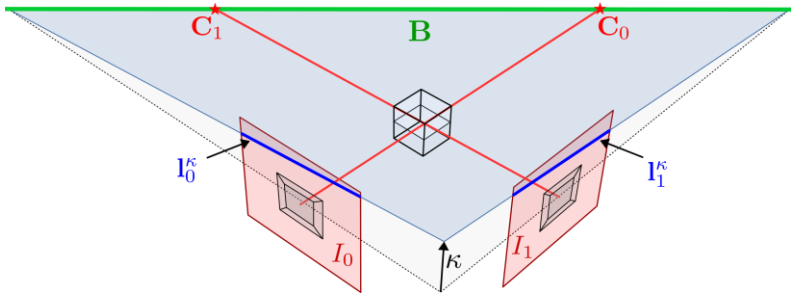
Current Research: Marker-Free Approaches

2D/3D bone registration

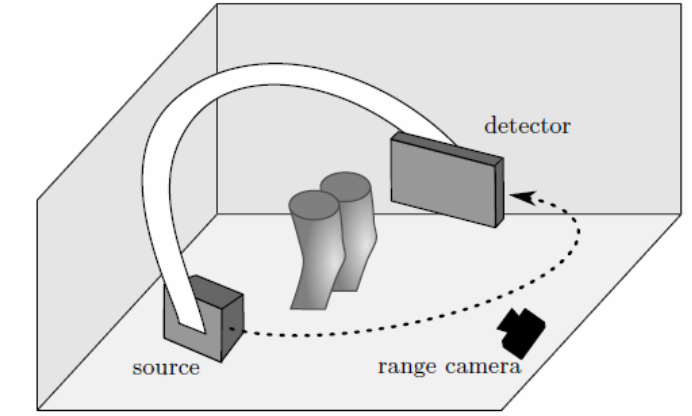
- use 3D segmented bones
- motion field for every bone

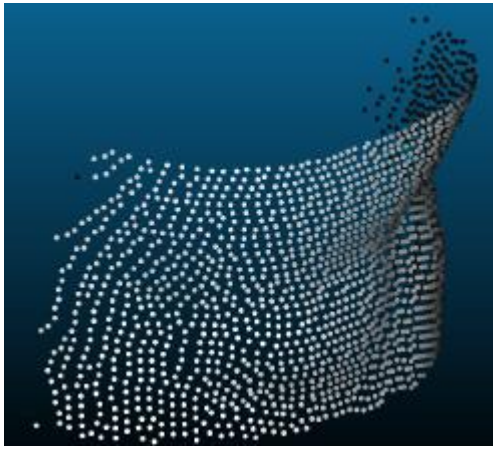


Epipolar consistency



Range imaging

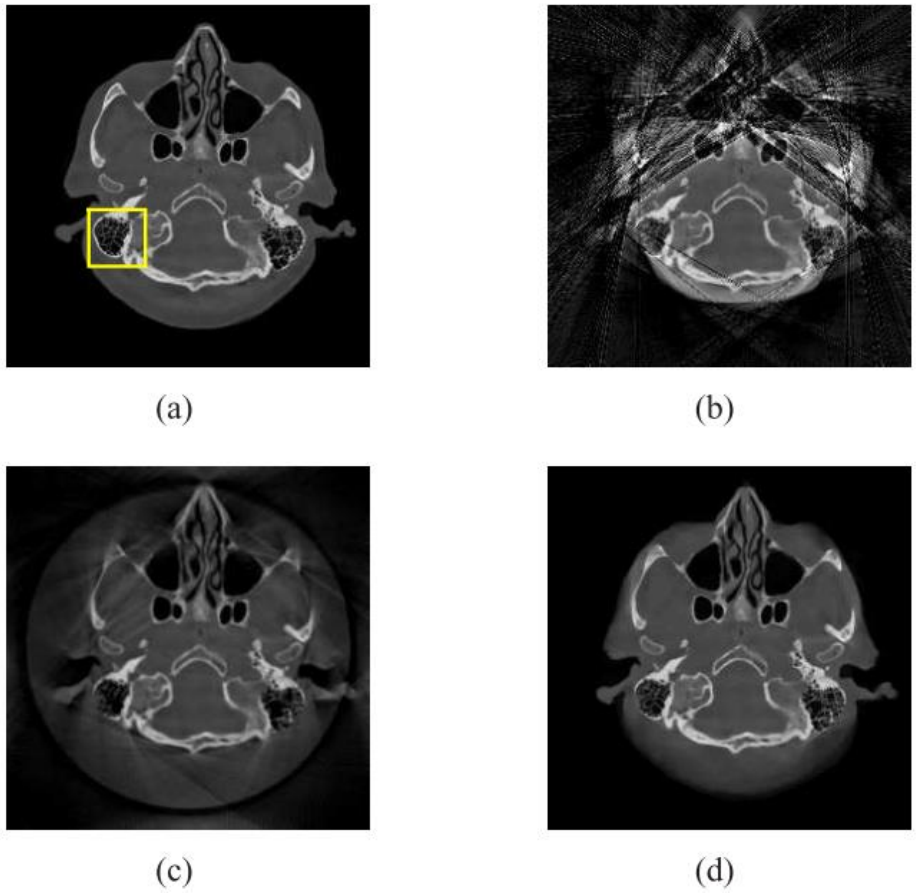




Outlook: Ideas for RSA

Direction of future research:
Reconstruction-based RSA

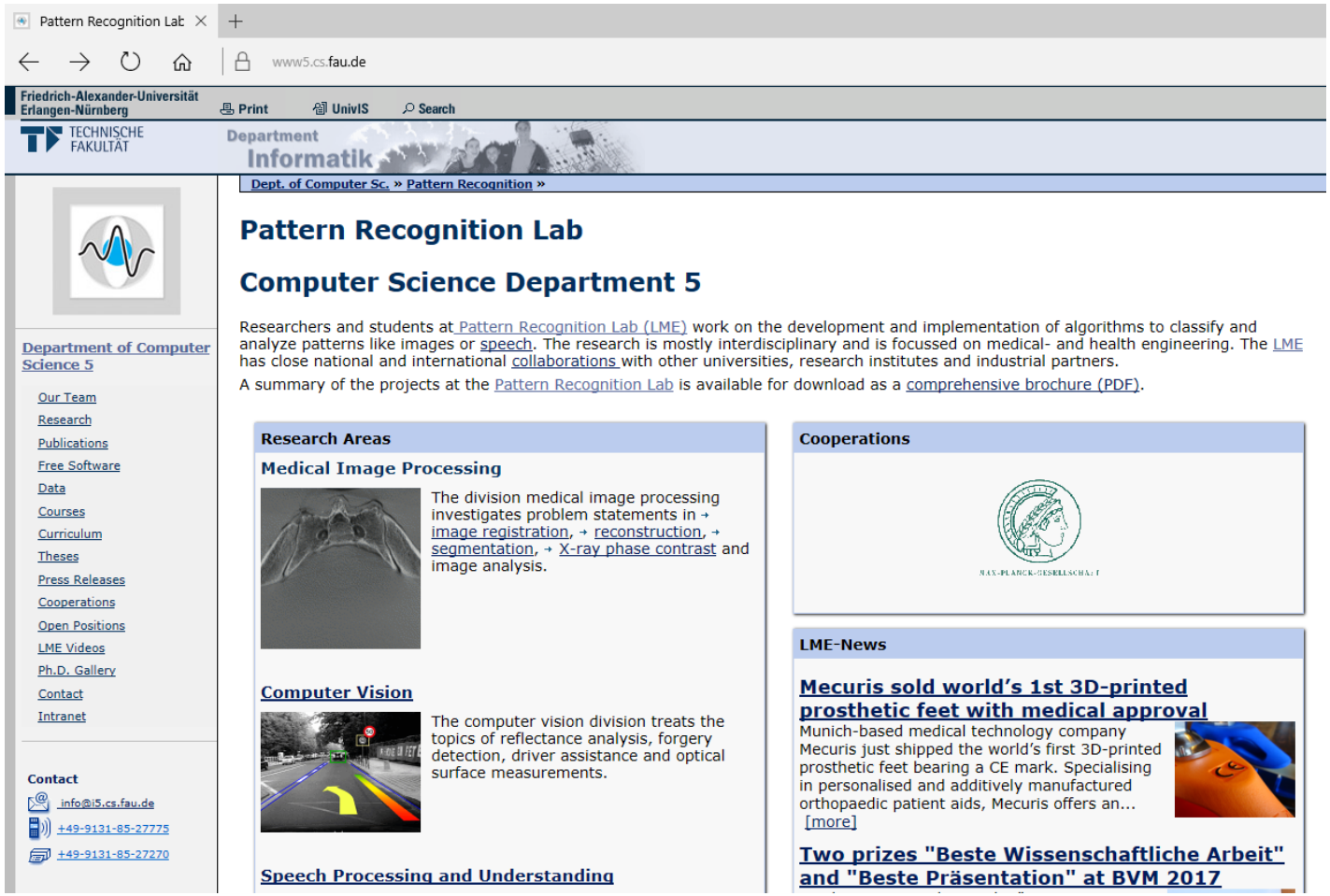
- Problem: Photon starvation
- Novel reconstruction techniques to enable marker-free RSA
  - Mixed 1 Bit Compressed Sensing
- Registration with CAD reference models
  - 2D/3D using X-ray images
  - 3D/3D using reconstructions



Thank you very much for your attention

Questions?

Pattern Recognition Lab



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