INSTITUTE OF SIGNAL PROCESSING
AND SYSTEM THEORY
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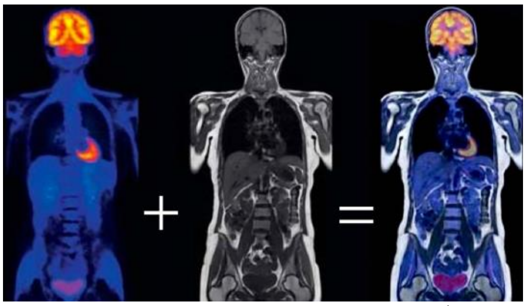
Bachelor/Master thesis, Research thesis/Studienarbeit in Medical Signal Processing

Processing of multidimensional datasets from different clinical imaging modalities, like Magnetic Resonance Imaging (MRI) or Positron emission tomography (PET) ranging from acquisition, reconstruction, optimization to analysis of datasets. Several different topics are possible:

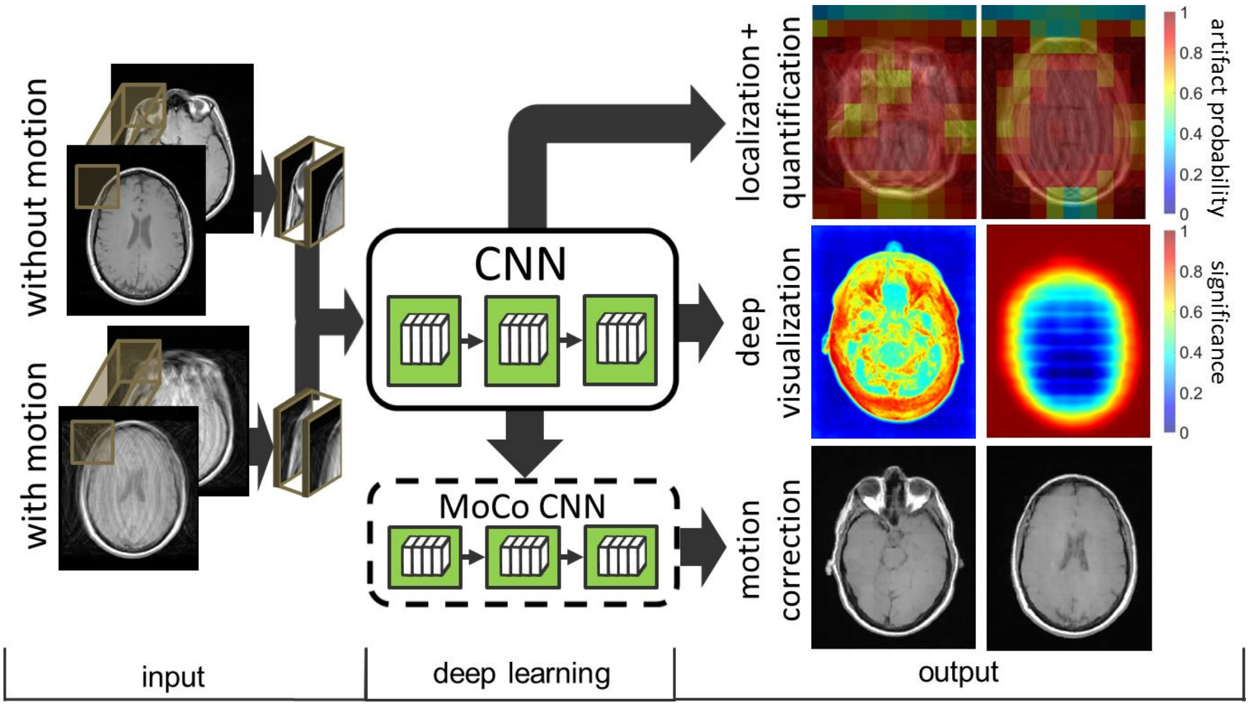


PET MRI PET/MRI

Deep Learning

MRI offers a variety of acquisition strategies and contrast mechanisms. In order to handle the huge amount of images per patient and assist the radiologist in a better diagnosis, an automatic image quality assessment based on the underlying application is of interest. The complex anatomic structure makes it hard for classical image quality metrics to evaluate the underlying quality. Furthermore MR artifacts (image distortions) even complicate this task. Hence machine-learning and deep learning approaches are investigated.

- convolutional neural networks for MR image artifact localization and quantification
- encoder/decoder or Generative adversarial networks (GANs) for MR motion correction
- deep visualization of trained architecture (transfer/feature learning)
- framework development: GUI, test environment, continuous integration, …
- identification of descriptive image features for MR image quality
- deep learning of image characteristics, distortions, ...
- unsupervised/semi-supervised classification via Deep Neural Network, SVM, ...
- training database selection via Active Learning or Reinforcement Learning



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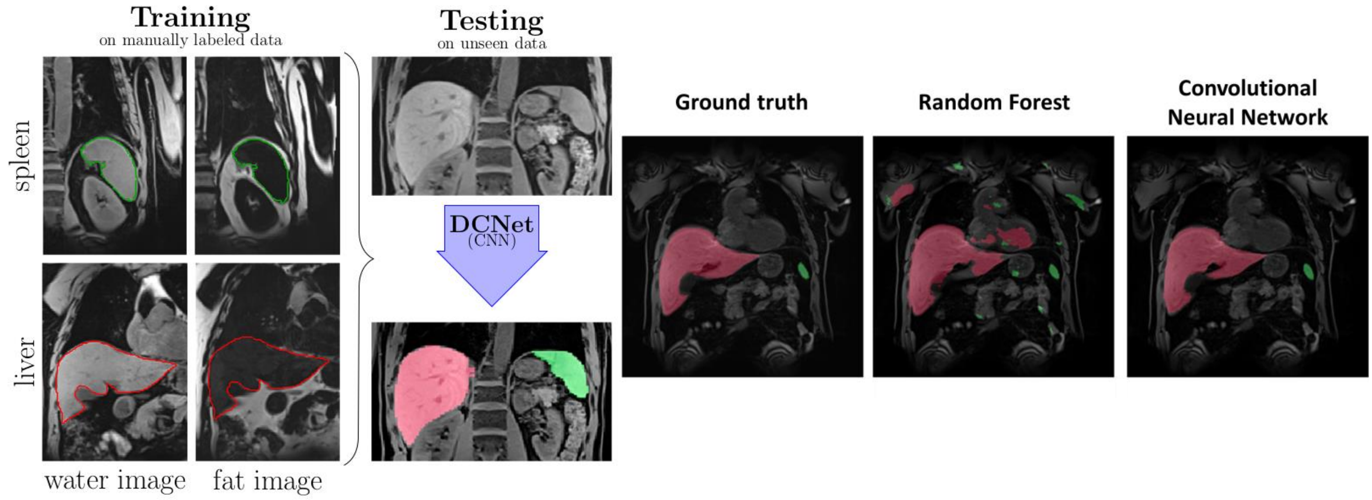
Semantic Segmentation

Automatic segmentation of organs or tissue compartments in whole-body MR imaging. Investigation of different convolutional neural network architectures for segmentation:
residual

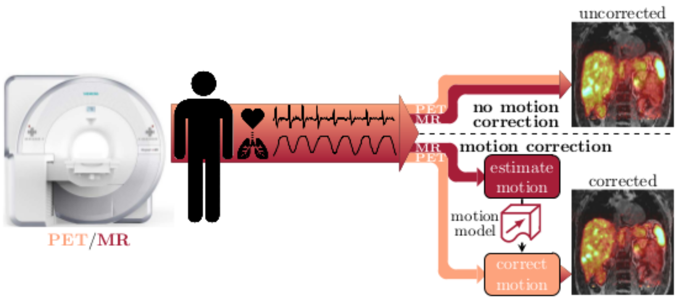


Motion Correction

Patient, respiratory and cardiac movements produce motion artefacts in the final image which reduce the quality and impair reliable diagnosis. The task is to accurately detect and correct the movements. High spatial- and temporal-resolved MR images need to be acquired over several respiratory and cardiac cycles under free movement conditions.

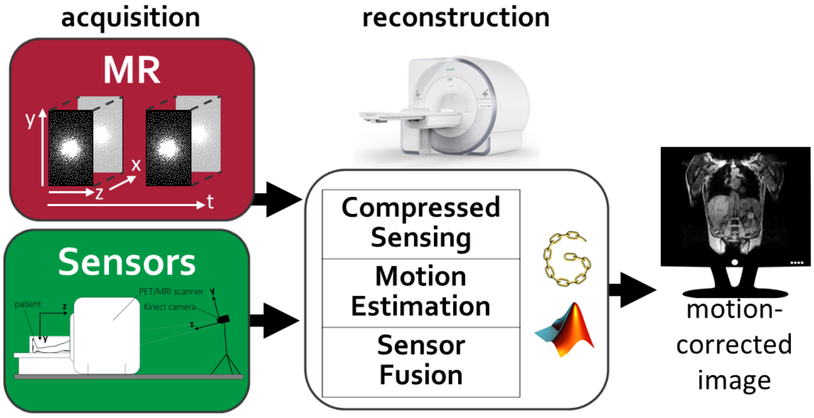
In acquisition step:

- sampling mask optimization according to movement cycle, SNR optimal sampling (image upscaling via deep neural network)
- monitor motion state by external sensors (Microsoft Kinect camera, respiratory belt, ...)



In reconstruction step:

- reconstruct motion-resolved image: Compressed Sensing reconstruction and motion estimation
- retrieve non-rigid deformations: image registration or motion correction via CNN
- map motion state to external surrogate signal (sensor fusion)
- framework development for Gadgetron



Prerequisites: Motivation and Matlab, Python, C++ (depending on the topic)