FUSIMO: A prototype for patient-specific prediction of focused ultrasound surgery in moving organs

High Intensity Focused Ultrasound

- Only about 30-35% of the patients with liver cancer and liver metastases are suitable for surgical resection.
- An alternative treatment is thermal ablation of the tumor by focused ultrasound (FUS).
- FUS therapy is non-invasive. In the liver, however, the location of the tumor is difficult to reach due to the rib cage, lungs and intestines.
- Another major challenge is the motion of the abdominal organs as the patient breathes.

The FUSIMO system supports the attending physician in assessing the feasibility of a procedure by simulating it beforehand. The physician is enabled to judge how a procedure can be conducted safely and successfully.

FUSIMO Project

The FUSIMO project is divided into the following tasks:

- Design and specification
- Motion modelling
- Ultrasound modelling
- Functional organ modelling
- Patient specific model integration
- Validation and evaluation

The main focus of the modelling tasks is patient specificity.

This is achieved by:
- Individual adaption of the simulation model and
- Patient individual breathing information.

Simulation Results Incorporating Motion

Simulation of FUS heating in a moving organ a) with fixed focal spot and b) with auto tracked focal spot.

FUSIMO Demonstrator

The whole workflow is integrated in a software prototype, which covers the whole planning phase of a patient-specific FUS application in moving organs.

It provides:

- Flexible scalable patient specific data-model
- Segmentation tools organs and lesions
- Definition of the target area and visual treatment planning
- Motion estimation of the patient using a motion model based on 4D MRI and additional US tracking information
- Multi level patient-specific simulation of the ablation necrosis taking into account
  - Heterogeneous tissue
  - Breathing motion
  - Heat transfer
- 2D and 3D visualization of derived data and results especially of the results.