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Temperature model for a ultrasound computer tomography demonstrator

Fig.1: 3DUSCT II imaging system

At KIT a novel imaging method, called 3DUSCTII, is under development. In this method ultrasound signals are used (A-Scans, ultrasound pressure over time) to reconstruct 3D image volumes of the female breast for early breast cancer diagnosis. For a demonstrator 157 ultrasound transducer array systems (so called TAS, see Fig. 2) were designed and built. The transducers act as receiver or emitter and are positioned around a measurement container (see Fig.1, centre in the patient bed). The used transducers have typically a centre frequency of 2.5 MHz and the USCT method uses therefore water as contact medium. In the USCT system are two calibrated PT100 temperature sensors and one integrated low accuracy temperature sensor per TAS, providing two sources of temperature with varying spatial and temporal resolution and quality.

Challenge

For the USCT imaging methods soundspeed knowledge uncertainties over the image volume should be smaller than ~ 0.5m/s (for ~0.2mm resolution), which corresponds also to temperature variations of ~0.25°C (at 35°C). Therefore a good knowledge of the temperature in the measurement container over time and space is required.
Influences on the Temperature model are on one hand the errors of the measurement devices, the heating and cooling sources (water evaporation, electronic devices heating, human body heating), water layering effects, noise in the DAQ system, and the sparsity of the available data (over time and space).

To achieve optimal imaging results a more accurate and advanced model of the temperature in the measurement container is required.

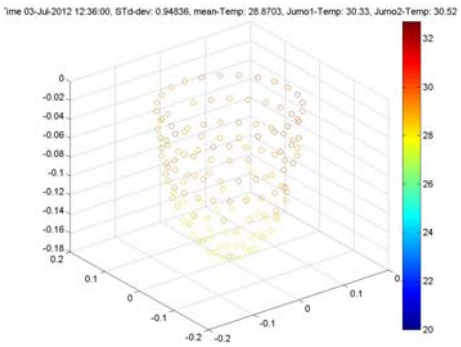

Fig. 2-USCT Temperature over the TAS positions (spatial)

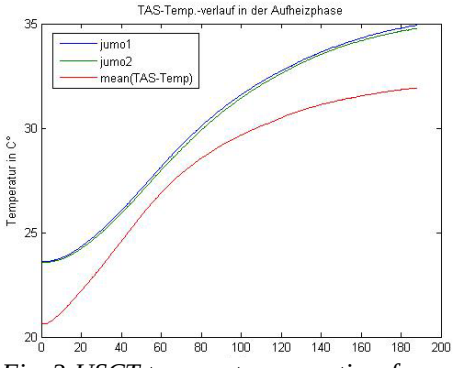

Fig. 3-USCT temperature over time for several temperature sources

Work:

- Expand the existing Matlab based temperature usage, analysis software and simulation software.
- Re-calibrate and evaluate the temperature measurement chain and devices.
- Evaluation of the temperature model with an image resolution comparison with a resolution exposing phantom object (bonding thread thinner than resolution).
- Writing of the report and documentation.

Required Skills:

- Knowledge about sensors and DAQ chains
- programming knowledge required (specifically Matlab)
- basic mathematics, statistics

Duration:

- 6 month work

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