Software Assistance for HIFU Therapy Planning

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Introduction

High intensity focused ultrasound (HIFU) is a promising technology for cancer treatment. Thereby, heating due to the focusing of the ultrasound non-invasively destroys the tumors. At the present state, the method is clinically restricted to uterine fibroids, adenomyosis, bone metastasis and prostate cancer. In abdominal organs as e.g. the liver, the motion due to breathing causes problems for the focusing. Further challenges are mainly generated by the different tissue properties, e.g. the absorption rate, of the diverse anatomical structures and the blood perfusion. The blood perfusion cools the tissue and therefore influences the resulting thermal necrosis considerably.

Methods

We present a software framework that incorporates the whole workflow of a HIFU therapy. The framework includes the loading of patient image data as well as image preprocessing steps like segmentation of the tumor, vascular system and structures at risk. After these preprocessing steps the sonications can be planned. The resulting tissue damage is calculated with a numerical simulation of the ultrasound pressure field and the corresponding temperature distribution. The simulation is based on patient specific data and incorporates the blood perfusion. A model for the supply and drainage of liver tissue through blood vessels allows estimating the remaining liver function during and after the focused ultrasound application. Every single step during the therapy planning is saved into a database and can manually be adapted afterwards.

Results

The framework provides a therapy planning from patient data loading over the placement of several sonications to the simulation of the corresponding tissue damage.

Conclusion

Further investigations and improvements deal with the modeling and incorporation of the motion and the corresponding adaption of the treatment by tracking the focus point or adaption of the simulation. Another extension will be the patient specific adaption of the simulation by identifying the individual material parameters from temperature measurements during the treatment.