Medical image computing for assistance in diagnosis and therapy

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Fraunhofer MEVIS, Institute for Medical Image Computing in Bremen/DE (formerly MVI’s Research), has chosen a disease-oriented approach for solving significant diagnostic and therapeutic problems. Fraunhofer MEVIS has especially focused on epidemiologically relevant diseases such as cardiovascular diseases, cancer, and brain, liver and lung diseases. Based on the highly efficient software platform McViLab, Fraunhofer MEVIS develops workflow-oriented software assistants that allow for efficient visualisation of medical data, highly reproducible quantification of anatomically and pathologically important structures with minimal user interaction as well as reliable risk assessment of complex surgery and interventions. The software assistants are developed by Fraunhofer MEVIS in close cooperation with a worldwide network of more than 100 clinical partners, and they are utilised by globally operating industrial partners from medical technology.

At this year’s IMAGE exhibition, Fraunhofer MEVIS presents software assistants for image-based diagnosis and therapy that cover a wide range of medical disciplines in clinical applications, from cardiac, breast and lung image analysis to radiotherapy, surgery and intervention planning. Visitors to the IMAGE exhibition are invited to experience in hands-on presentations the capabilities and usefulness of modern image-based software assistants for quantitative image analysis and therapy planning that are increasingly integrated into the clinical workflow.

Important take home messages are:
- **Multi-modal radiotherapy planning:** Modern radiotherapy requires a combination of various modalities. Novel software tools facilitate the analysis and representation of image data from different modalities for diagnosis and radiotherapy planning. They combine state-of-the-art image analysis, e.g. for perfusion and diffusion imaging, with registration algorithms and fused visualisations.
- **Cardiac MRI:** Multidirectional phase-contrast MRI allows the acquisition of time-resolved velocity fields of cardiac and vascular blood flow. Based on cardiac MRI imaging, specialised software tools allow for the assessment of blood flow and vessel wall. These tools offer interactive exploration and analysis methods for velocity-encoded phase-contrast MRI images and multi-contrast MRI plaque images.
- **Breast imaging:** Today, a variety of imaging modalities and image-guided biopsy procedures exist to identify and characterise morphology and function of suspicious breast tissue. It is a major challenge to seamlessly integrate the available multi-modal images and the patient information on a single clinical workstation. Current research at Fraunhofer MEVIS focuses on solutions for computer-assisted characterisation of breast lesions on MRI in order to optimally support radiologists and surgeons for segmenting lesions and planning the intervention.

The clinical impact of the image-based software assistants developed by Fraunhofer MEVIS is manifold. For instance, changes in tumour volumes can be measured earlier and more precisely compared to the diameter-based standard RECIST criteria, thus allowing an improved monitoring of chemotherapies. Physicians can identify ineffective treatments earlier and, therefore, avoid unnecessary adverse effects in patients and reduce costs. The software assistants for liver surgery planning have been used worldwide in more than 3,700 clinical cases for oncologic resection and transplantation. The software assistants presented at the IMAGE exhibition support radiologists and surgeons in their clinical work and provide a basis for evidence-based medicine.

Pulmonary CT: Lobe-based quantification and visualisation of emphysema distribution.

Reconstruction of the blood flow in the heart and the aortic arc based on phase contrast MRI.