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Comparison of registration strategies for USCT-MRI image fusion: preliminary results

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Comparing USCT to well-known MRI is an essential step to evaluate the clinical value of USCT. Yet the different conditions of the breast either embedded in water (USCT) or in air (MRI) prevent direct comparison of tissue structures due to non-linear deformations of the breast in 3D. Previously we presented an image registration simulating the MRI subjected to buoyancy. In this work we compare it with a new strategy by applying gravity to USCT to match the breast shape in the MRI.

(2) Material and Methods

A biomechanical model is constructed from the segmented USCT resp. MRI volume. A gravity body load is applied (USCT) or buoyancy is simulated by inverting the gravity body load (MRI). Material parameters as well as dataset rotation and cropping are automatically optimized using simulated annealing to maximize the surface agreement. Subsequently a free-form deformation is applied to further refine the matching of the outer surfaces of USCT and MRI. The registration accuracy is evaluated based on annotated tissue structures in USCT and MRI by measuring the average mutual distance of their surface points.

(3) Results

The registration was applied to 9 datasets from 8 patients. Both registration strategies revealed similar registration accuracies (MRI to USCT: mean = 5.6 mm, median = 5.6 mm, USCT to MRI: mean = 6.6 mm, median = 5.7 mm). Compared to a simple alignment of datasets the registration error is reduced by approx. factor 2. The parameter optimization resulted in similar average material stiffnesses for both registration strategies, confirming that the optimization is able to derive a robust patient-specific parameter setting.

(4) Discussion and Conclusion

Image registration of USCT and MRI allows to delineate corresponding tissue structures in both modalities in the same or nearby slices. Our preliminary results indicate that both simulation strategies seem to perform equally. Yet the newly developed deformation of the USCT volume is less computationally demanding: as the breast is subjected to buoyancy and can thereby serve as the unloaded state while for the contrary strategy we have to solve an inverse problem.

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