Liver Segmentation in Contrast Enhanced Helical CT-Scans

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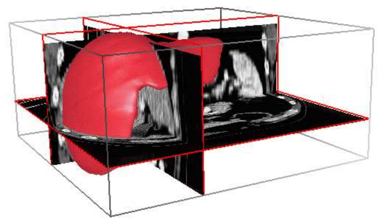
Introduction. We intend to segment the liver from abdominal helical CT-Scan images enhanced with a contrast agent acquired in the radiology department of IRCAD. Extraction of liver models is useful for surgery planning or simulation. We use constrained deformable models that take advantage of a prior knowledge of the liver shape to perform segmentation.

Materials and Methods. Segmentation of the liver is made difficult by the low contrast in CT images. We use a reference liver model that is laid inside the volumetric image (see figure). We extract a gradient map and main edges from the image. Forces are computed from this boundary information that attract the deformable model toward the image edges. The model must be deformable enough to match the drastic inter-patient variability of the liver shapes encountered. Yet it has to be robust due to the noisy, textured, and low-contrast images. We use the simplex mesh framework that ensures good geometric properties of the resulting models. A shape constraint mechanism was developed, thus the model benefits of its a priori shape knowledge throughout the deformation process. A hybrid deformation scheme that allows us to control the degrees of freedom of the model through a single locality parameter is also used. The segmentation protocol first performs a registration of the model with the data by applying rigid and affine transformations. When a better initialization state is obtained and the model is less sensitive to outliers, the hybrid deformation scheme is used to allow local deformations. The locality parameter is smoothly increased until the surface of the model locks on boundaries in the image.



Results. This segmentation algorithm has been used for the segmentation of ten CT-scan images. The segmentation results were validated by radiologists. The resulting models are used for laparoscopic surgery simulation.

Conclusion. Liver models of the patients with high geometric quality were built. This algorithm is not limited to CT-scans and it can be used for the extraction of other anatomical structures. We successfully applied our algorithm for the segmentation of brain ventricles from MR images of the head.