Registration and Segmentation for the High Resolution Visible Human Male images

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Background/Problem

As a part of the Visible Human project [1] of National Library of Medicine, two sets of cryosection images of a human male (VHM), low (LR) and high (HR) resolution, have been created. Easy access to the registered and segmented LR images has made it possible to generate 3D models for medical simulations. It would be desirable to generate models based on the HR images since they contain more detailed anatomical information. In this paper we present an accurate method for registering and segmenting the HR images.

Tools and Methods

Set of tools used includes: our registration algorithm for images requiring rigid body transformations [2, 3], a segmentation tool [4] that takes advantage of the already established segmentation information for the LR images, and a real-time model generation system [5] that produces volumetric and surface based virtual body structures.

Our method solves several critical problems for obtaining proper alignment, such as HR images requiring iterative scaling and rotational corrections, as they vary in size and in their angular displacement with respect to a reference image. Since the LR images are registered, the tool registers each HR image with its corresponding scaled LR image and this process results in the registration of HR images with respect to each other. Next the segmentation information for the scaled LR is used to create mask files for structures in the HR, thus segmenting the HR images. The resultant data used to create and interface with volumetric virtual anatomical structures validates our procedure.

Validation Data

The quality of the models created by our method (Figure 1) confirms its high-accuracy. Currently, we have registered and segmented over a thousand slices.

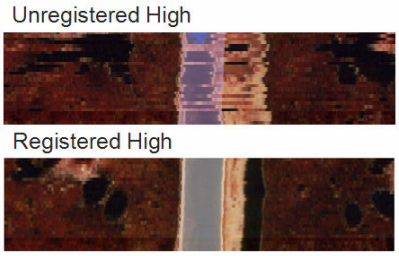

Figure 1: Appearance of Inferior Lobes of a lung modeled in 3D and sliced, obtained with images with and without registration. Number of registered and segmented slices used: over 75

Conclusions/Discussions

Using the tools and methods described above, registration and segmentation of HR images has been achieved and high quality anatomical models have been created and used in several medical applications [6, 7].

The poor reliability of the fiduciary marks of the HR set made it necessary to develop a registration process using intrinsic landmarks of the HR images. This process works well for most images. In some images, which appear distorted by slicing errors, a more sophisticated approach is needed to obtain accurate registration and segmentation. For these slices satisfactory results have been obtained by manual refinement of edges of individual structures. In general, small structures seen in HR images but not visible in the LR images are not segmented. We expect that this problem will be solved by a tool, now being built, that will allow us to incorporate just segmented structures into the existing database. The method used to register the HR images can be extended to other applications [8] requiring registration of image data of the same patient at different times, for example when tracking a tumor.

References

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