Visible Human Image Data—Efficient Representation and Visualization Techniques

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The Visible Human (VH) dataset consists of color images of cryosections of a pair of human cadavers, in addition to MR and CT data. The color images are available at two different resolutions: approximately 2Kx2Kx24 b/p images directly captured by a CCD camera during cryosectioning, and high resolution 4Kx3.5Kx24 b/p images from scanning the 70mm photographs taken at the same time. These RGB color images are of particular interest since they show portions of anatomy (organs, tissue, arteries, etc.) in each cross-sectional slice in their natural color. To create surface- or volume-rendered anatomic objects from these slice images, it was necessary, as a first step, to segment and label the anatomy in each slice. This was done by domain specialists who completed this step for the thorax region of the male cadaver, using the high resolution images to ensure the detection of the smallest detail possible.

To define a segmented shape in a slice, a 1-bit mask was created for each anatomic structure in every slice in the thorax, and a label assigned to it. Other 1-bit masks corresponding to the same structure in adjacent slices were assigned the same label. A stack of such 1-bit masks in multiple slices therefore defined the entire (volumetric) anatomic structure. Such stacks were generated for 433 structures in the thorax. Since the mask files range in size from 1 KB to 300 MB, to organize and display the mask data along with the original RGB images in real-time on the web posed a difficult problem. To address this problem, we used an anatomical hierarchical tree to organize all the masked out structures. Then, traversing the anatomical tree generated an order for the anatomical structures within an area or volume of interest. This order was then used to generate a byte-mask image for each cross-sectional image and a byte-mask image stack for each volume of interest. This was an efficient way to represent the structures since each pixel value in a byte-mask image is an integer ranging from 0 to 255. By so doing we allowed up to 256 possible structures to be identified in each slice, each structure uniquely represented by a different number in the 0-255 range. This number can be looked up in a label table file (one such file for every byte-mask in a slice, as well as for a byte-mask stack for a volume of interest) to extract the name of the corresponding structure. The role of the byte-mask is in both allowing the rendering of anatomic objects as well as identifying the labels of structures in images requested by users through a web interface.