Topology-controlled Volume Rendering

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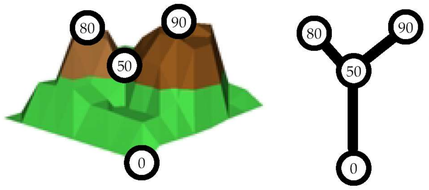
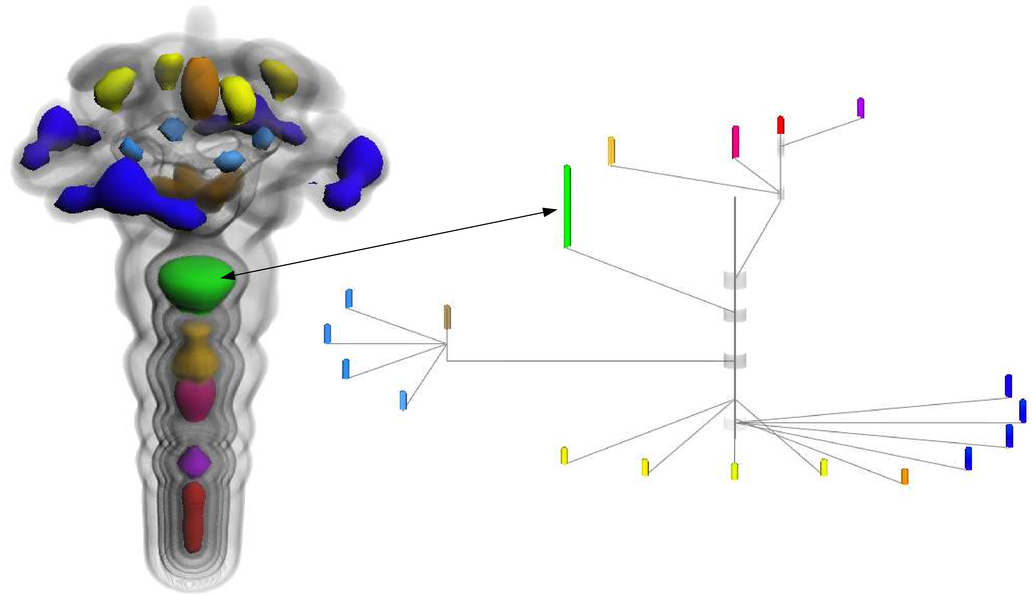
Topological structure can guide the data exploration process, or the topology itself may be of interest. Our method of direct volume rendering is based on level-set topology. We use topological structure defined by the contour tree (a type of Reeb graph) to control optical properties for rendering. Color and transparency can be controlled independently for each level-set component.



A simple contour tree for 2D data

Rendering Method

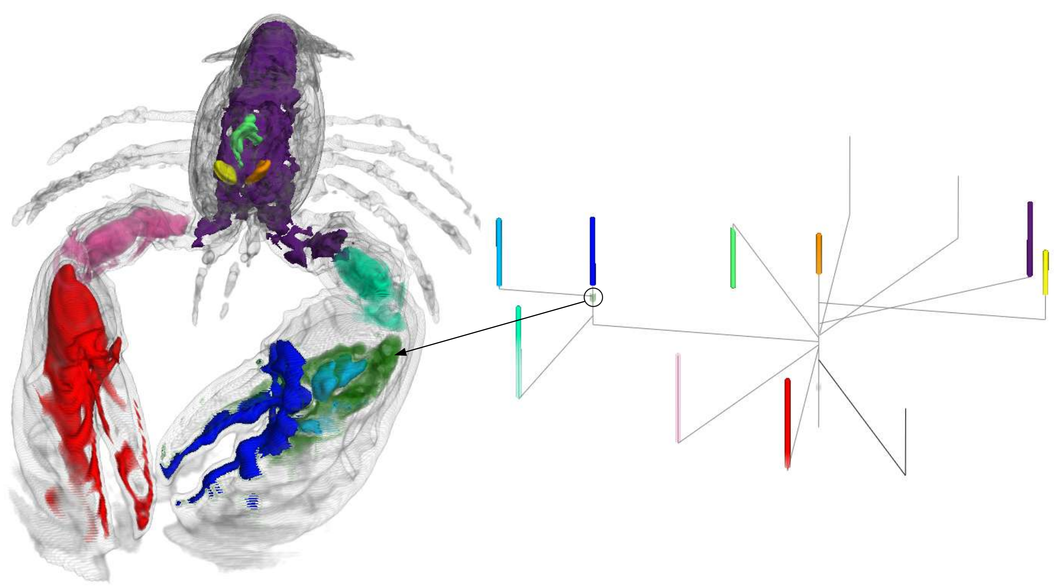
We use a segmentation which is implied by the contour tree. Branches of the tree represent distinct components of the isosurface. Segments are defined by the volumes which are swept by these components when the isovalue is varied. If data samples are sparse, and an interpolant is used, the resolution of the segmentation can be finer than that of the samples. This simulation dataset consists of only 64^3 samples.



Interface

The contour tree serves as an abstract representation of the topological structure. The tips of the branches represent peaks in the data, and the connections reveal the manner in which structures are nested.

Modern graphics hardware is capable of processing the added topological information on the fly, rendering images at interactive frame rates. This CT scan of a lobster, which measures 301x324x56, was rendered at ~2 frames/sec on consumer-grade hardware.



A hierarchical tree layout allows for color properties to be applied to only the most prominent features, then automatically propagated down to lesser features. Fine details can be revealed on demand.

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