Automatic Cross-Sectioning Using 3D Field Topology Analysis

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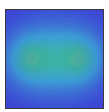
Goal

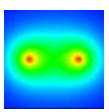
Visualizing the complicated inner structures of 3D volume datasets

Existing Visualization techniques


Volume Rendering


Isosurface Extraction

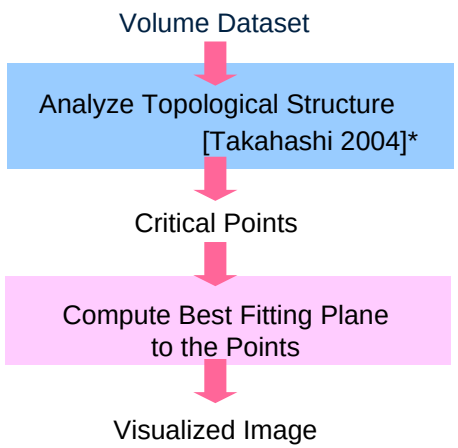
It is difficult to see the detailed structures because of occlusion


Cross-Section

Cross-sections reveals the internal structures well, but it is tedious to find ideal cross-section manually

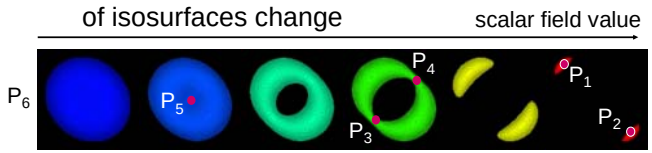
Our Approach

Automatic generation of cross-sections that reveal characteristic structures of a volume dataset



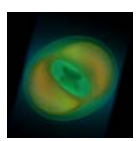
Extraction of Critical Points

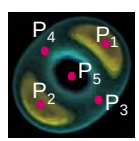
We first locate the points where the topology of isosurfaces change



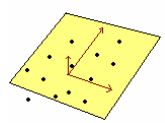
Computing Best Fitting Plane Using PCA

We then find best fitting plane to the critical points


Volume Dataset



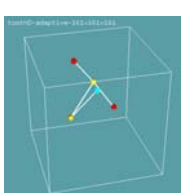
Cross-Section



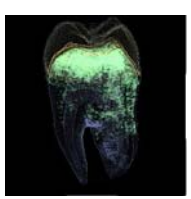
Application to Real Datasets

(1) NML tooth volume

The cross-section reveals the detailed internal structure more clearly

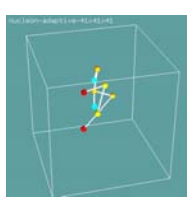

Critical Points

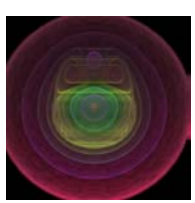

Volume Rendering

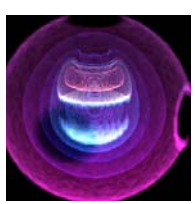

Cross-Section

(2) The nucleon in the atomic nucleus of ^{16}O

The cross-section includes important isosurfaces

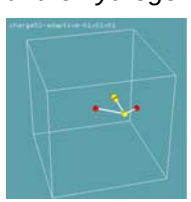

Critical Points

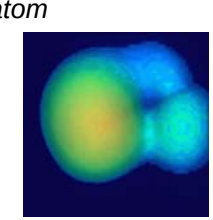

Volume Rendering

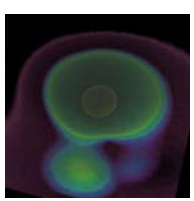

Cross-Section

(3) The hydrogen ion-atom collision

Our system successfully finds the characteristic cross-section that contains a point where the proton collides with the hydrogen atom


Critical Points


Volume Rendering


Cross-Section

Future Work

- Generate cross-sections including curved surfaces and multiple planes
- Try other methods to analyze structures (medial axis, generalized symmetry, etc.)
- Apply to other datasets (vector or tensor field)

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* S. Takahashi, Y. Takeshima and I. Fujishiro. 2004. Topological Volume Skeletonization and its application to transfer function design. Graphical Models, 66(1), 22-49.