Surface Modeling and Display from Range and Color Data

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Introduction

Goal

- develop robust algorithms for constructing 3D models from range & color data
- use those models to produce realistic renderings of the scanned objects

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Surface Reconstruction

Step 1: Data acquisition
Obtain range data that covers the object. Filter, remove background.

Step 2: Registration
Register the range maps into a common coordinate system.

Step 3: Integration
Integrate the registered range data into a single surface representation.

Step 4: Optimization
Fit the surface more accurately to the data, simplify the representation.

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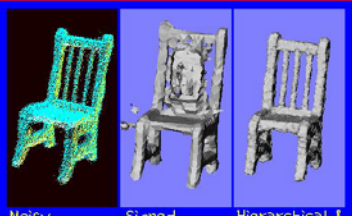
Problem



Noisy registered data | Signed distance fn & marching cubes | Hierarchical & directional space carving

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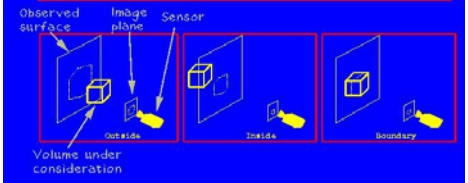
Carve space in cubes



Label cubes

- Project cube to image plane (hexagon)
- Test against data in the hexagon

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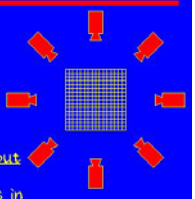
Several views

Processing order:
FOR EACH cube
FOR EACH view



Rules:
any view thinks cube's out
=> it's out
every view thinks cube's in
=> it's in
else
=> it's at boundary

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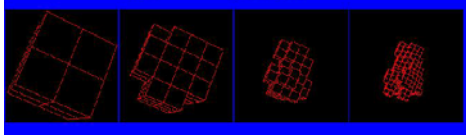
Hierarchical space carving

- Big cubes => fast, poor results
- Small cubes => slow, more accurate results
- Combination = octrees

RULES:
- cube's out => done
- cube's in => done
- else => recurse



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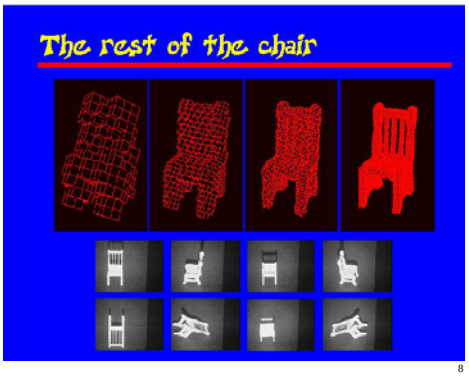
The rest of the chair



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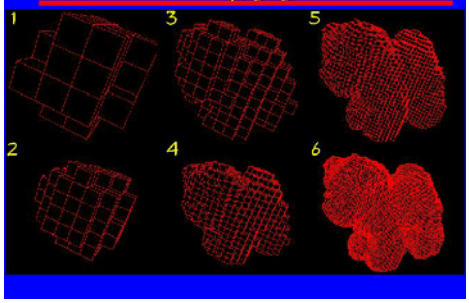
Same for a husky pup



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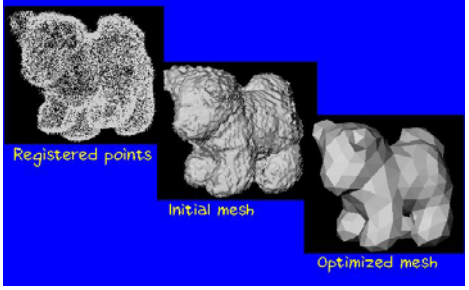
Optimizing the dog mesh



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View dependent texturing

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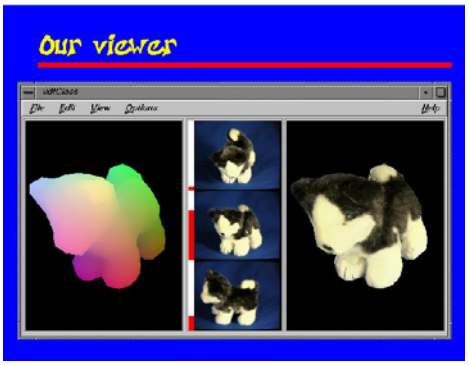
Our viewer



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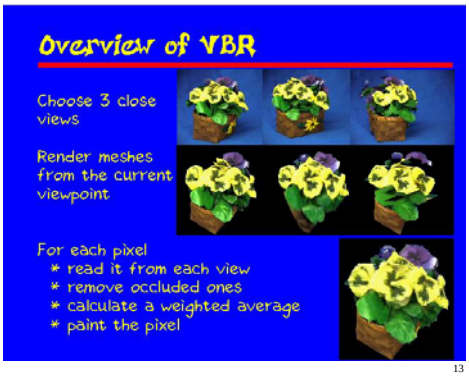

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Reconstruction of Blood Vessel Trees from Visible Human Data

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Introduction

- **Goal**
  - to reconstruct the blood vessels of the lungs from Visible Human Data
- **Computer vision**
  - semi-automation
  - low-level image processing
  - model construction

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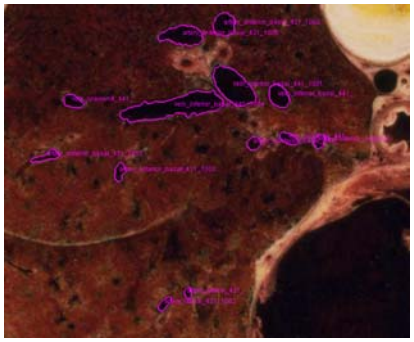
Visible Human Data: Slice through the Lung



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Problems Encountered

- **Data source**
  - black spots that are not blood vessels
  - variations of lighting
- **Characteristics of blood vessels**
  - similar color surrounds
  - lack of knowledge
  - close location
  - shape variety
  - continuous change not expected
  - dense data

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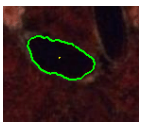
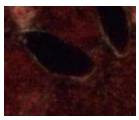
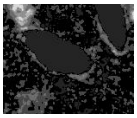
Finding the contours of a vessel being tracked (1)



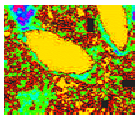
Previous contour



Current slice



EM Segmentation



False color for the segmentation

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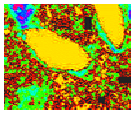
Finding the contours of a vessel being tracked (2)

- The results after selecting regions of similar color to the tracked region



Segmentation result

Selected regions

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Finding the contours of a vessel being tracked (3)

- The results after selecting the region that overlaps most with the previous contour

Selected regions

Region that overlaps most

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Find the contours of a vessel being tracked (4)

- The results after morphology to close holes and remove noise

Selected region

After noise removal

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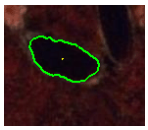
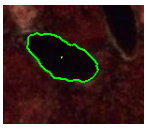
Find the contours of a vessel being tracked (5)

- The contour is determined through a fast-marching level-set approach



Previous contour



Current contour

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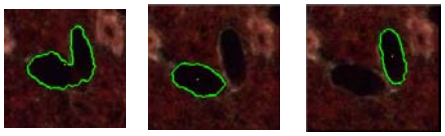
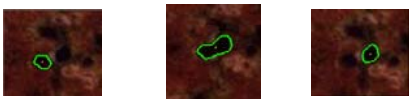
How branching is handled

- One contour divides into two



- Two contours merge into one



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The use of resampling when the axis is not vertical

- **Track** the axis through the center points of found contours
- **Fit** a spline curve
- **Resample** the data perpendicular to the spline curve
- Use the resampled contours for model creation

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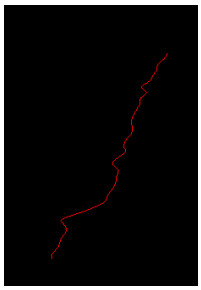
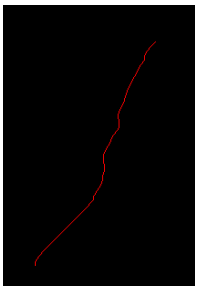
Detect the axis



Center points of found contours



Spline-fitted axis

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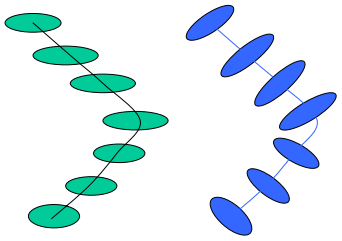
Resample the data perpendicular to the spline curve



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Overall Procedure for finding Vessel Trees

- The user **selects** a starting point
- The program automatically **tracks** the selected vessel and any branches it finds
- The program creates a **generalized cylinder** representation of the vessel tree
- The user may select more starting points

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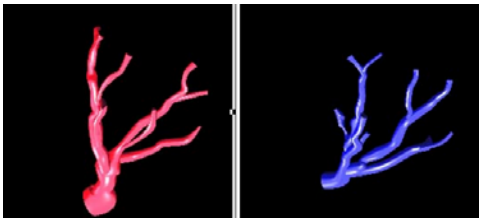
Some Initial Results



Artery tree from single seed

Vein tree from single seed

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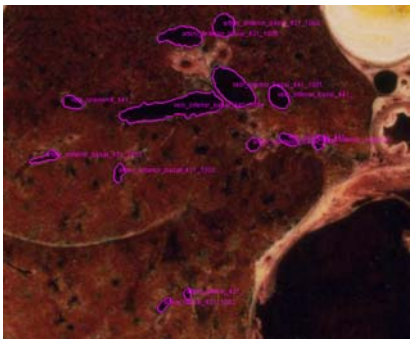
Typical Cross Section



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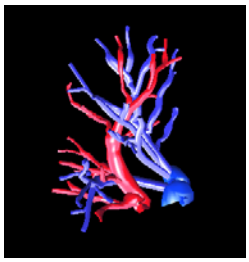
Results : blood vessels in right lung from previous section



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